January 1985

Yakima River Spring Chinook Enhancement Study

Annual Report 1984

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Yakima River Spring Chinook
Enhancement Study

Annual Report FY 1984

by

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Yakima Indian Nation

Fisheries Resource Management

Prepared for
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Bonneville Power Administration
Division of Fish and Wildlife

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SUMMARY

1. Median date of emergence for 5 redds capped on the Yakima River extended from April 9 to May 13.

2. The mean number of temperature units required for 50% emergence was 1967.

3. The mean survival to emergence was 20.6%, and ranged from13 to 30.6%.

4. There was a significant relationship ($P \leq .05$; R=80) developed between survival to emergence and gravel composition, measured by the fredle index.

5. The median capture dates of newly emergent fry on the Yakima and American Rivers were April 15 and April 17, respectively.

6. Distribution studies showed fish present throughout the basin during winter and spring months, with few fish below rivermile 118 during the summer. The greatest concentrations of fish were located in the Yakima Canyon near rivermile 135.

7. Juvenile spring chinook were found one mile upstream during the summer in Manastash and Swauk Creeks, and .9 miles upstream in Wide Hollow Creek in January, 1984.

8. It was estimated that 178,230 wild spring chinook smolts and 26,162 hatchery spring chinook smolts passed Prosser Dam in 1984.

9. There were 87,277 wild steelhead smolts and 15,745 hatchery steelhead smolts that reached Prosser Dam in 1984.

10. Estimates for wild and hatchery fall chinook smolts to Prosser Dam were 52,189 and 72,186 respectively.

11. Survival rates for spring chinook released from earthen ponds, and those released directly to the Yakima River after trucking were 66.4% and 42.8%, respectively.

12. It was estimated that 32.6% of the hatchery spring chinook fingerlings released in the Upper Yakima River in June migrated past Prosser in July.

13. 32% of the hatchery steelhead smolts and 69.6% of the hatchery fall chinook smolts successfully migrated past Prosser in 1984.

14. Total run to the river of Yakima River Spring Chinook was 2677, of which 1579 were counted at Roza Dam. It was estimated that 809 adults migrated to the Naches River.

15. 274 four year old spring chinook returned to the Yakima River from a release of 401,714 smolts in 1982. This results in an estimated return rate of .068%.

16. The run timing of hatchery spring chinook to Roza Dam was 13 days earlier than for wild fish.

17. 194 four year old spring chinook returned to the Naches River from a release of 100,050 smolts in 1982. This results in a return rate of .19% for this group.

18. Median survival rate of spring chinook smolts entering Chandler Canal was 44.6%. Survival ranged from 29 tc 76.7%.

19. 1899 dead spring chinook fingerlings were captured on rotary drum screens at Roza Dam from June 18 to August 14.

INTRODUCTION

The population of Yakima River spring chinook (*Oncorhynchus tshawytscha*) has been drastically reduced from historic levels reported to be as high as 250,000 (Smoker, 1956). This reduction is the result of a series of problems; mainstem Columbia dams, dams within the Yakima itself, severely reduced flows due to increased irrigation diversions, increased thermal and sediment loading, and over fishing. Despite these problems, the native run of spring chinook in the Yakima River is continuing at levels ranging from 400-3,000 since 1957.

Studies by Major and Mighell (1969) showed a high survival from egg deposition to the smolt stage, and preliminary data based on releases of spring chinook into the Wenatchee River from 1977-1981 indicate an ocean harvest rate of approximately 11% (Washington Department of Fisheries, unpublished report). These factors, coupled with the fact that smolts leaving the Yakima River have only four mainstem Columbia dams to navigate make the Yakima River watershed the best mid-Columbia drainage to develop spring chinook enhancement techniques.

In October, 1982, the Bonneville Power Administration contracted the Yakima Indian Nation to develop methods to increase production of spring chinook to the Yakima System. The Yakima Nation's policy of enhancement encompasses an approach of maintaining as much as possible the genetic integrity of the spring chinook stock native to the Yakima Basin. Relatively small numbers of cultured fish have been released into the basin in past years, and data from the Wenatchee System indicates a return rate from hatchery smolts of less than .25% (Mullan, 1982). The low return rates indicate that few fish would have returned from these small releases. With this information, it was decided that any fish introduced into the Yakima System would be coded wire tagged to evaluate the efficiency of various release methodologies and to distinguish the origin of returning adults.

The goal of this study is to develop data that will be used to present management alternatives for Yakima River Spring Chinook. The approach has two objectives. The first objective is to determine the distribution, abundance and survival of wild Yakima River spring chinook. Naturally produced populations will be studied to determine if these runs can be sustained in the face of present harvest and environmental conditions. This information will be gathered through spawning ground surveys, counting of adults at Prosser and Roza fish ladders, and through monitoring the tribal dipnet fishery. Concurrent studies will examine potential habitat limitations within the basin. Presently, survival to emergence studies, in conjunction with substrate quality analysis is being undertaken. Water temperature is monitored throughout the basin, and seining takes place monthly to evaluate distribution and abundance. The outcome of this phase of the investigation is to determine an effective manner for introducing hatchery stocks that minimizes the impacts on the wild population.

The second objective of this study is to determine relative effectiveness of different methods of hatchery supplementation. This analysis is divided into four segments. (1) When should fish be released? Smolt releases are the norm, but fingerlings were released in June, September, and November, 1984, and adult returns will be monitored. In addition, downstream survival of these smolts will be evaluated. (2) Where should fish be released? Based on distribution studies, fish will be released in areas that minimize competitive interactions with wild fish. This will be done by scatter planting fish so densities in the river will low enough to minimize competition for food or space of both the hatchery and wild stocks. (3) How should fish be released? In the past, fish have either been transported from a hatchery and released into the Yakima River, or raised in rearing ponds. These methods, as well as the use of acclimation ponds will be evaluated. (4) which stocks should be released? Smolts will be released as hatchery X hatchery, hatchery X wild, and wild X wild crosses to determine the effect of parentage on the success of various releases. Success will be measured by the number of adults returning, as well as whether spawning timing is similar to the wild stock.

This project is a multi-year undertaking that will evaluate different management and enhancement strategies. At the conclusion of this study, a series of alternatives will be developed that can be used to determine how best to manage the runs of spring chinook in the Yakima Basin. An annual report was presented in 1983 (Wasserman and Hubble, 1983). A detailed description of methods and materials used in 1983 can be found therein.

Methods:
Part 1:
Natural Production Investigations

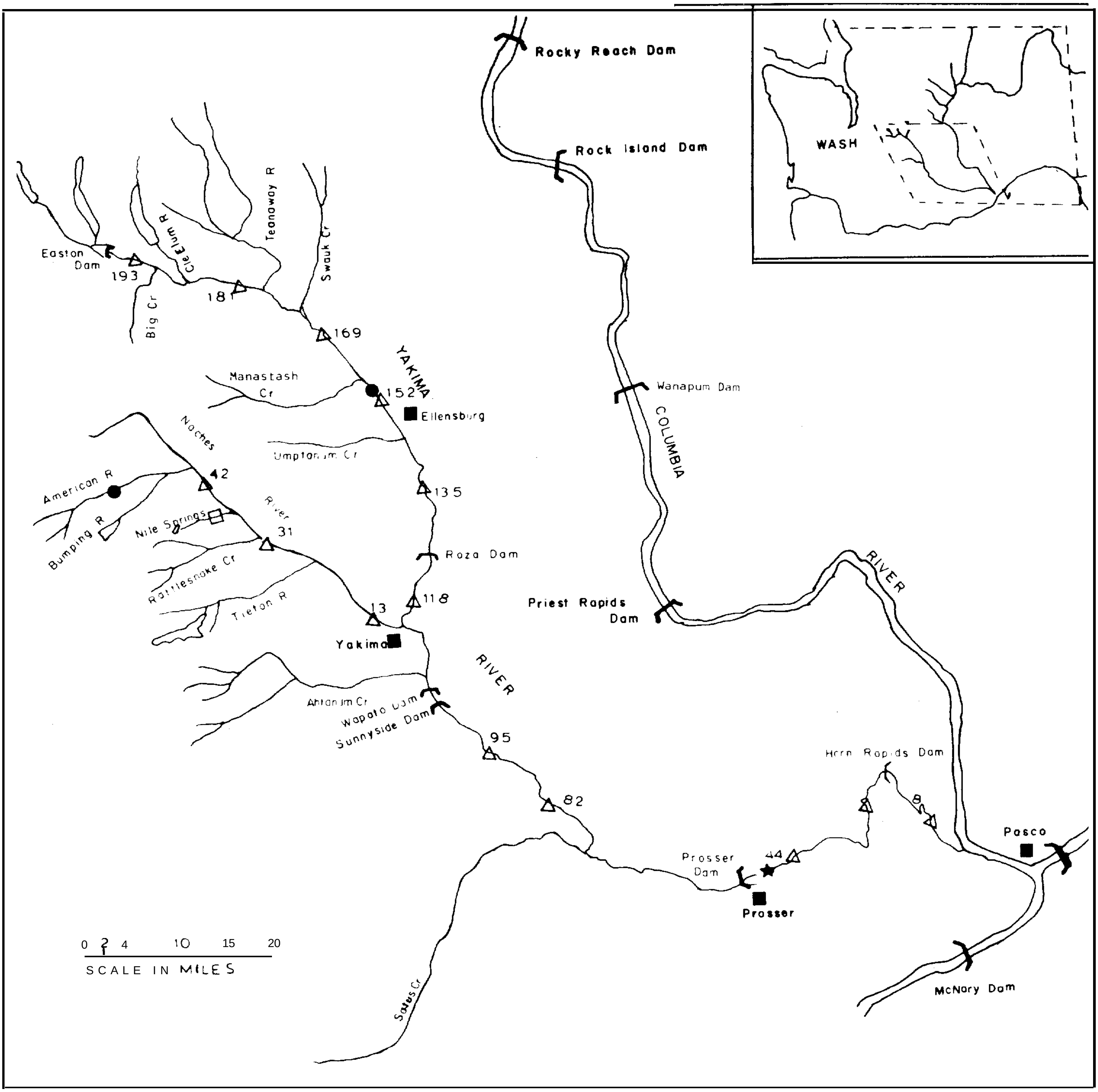
Survival to Emergence Studies

Methods for capturing fish and identifying redds on the spawning grounds were detailed in Wasserman and Hubble.(1983). In early February, 1984, redd caps (1/8" mesh) were placed over seven previously located redds in the upper Yakima River near Easton (Fig. 1). Redd cap design followed that of Tagart (1976). Caps were constructed to extend a distance of at least one meter from the crown of the redd on all sides. Edges of the cap were buried to a depth of nine inches (Plate I). All caps were installed by February 17, 1984, and each was checked at least twice weekly until the first fish was captured. Thereafter,traps were checked four times each week. Survival was calculated as the total number of emergent fry divided by the number of eggs deposited, based on a previously defined lengt-fecundity model.

Females were again captured in 1984 for on-going survival to emergence studies, and associated substrate quality was assessed. Gravel quality was assessed in three ways. Four gravel samples were taken on each riffle where a redd was capped. Regression analysis was undertaken to determine relationships between survival to emergence and percent composition of fine gravels. For five redds successfully capped in 1984, survival was regressed against the percent of the entire gravel sample retained in each of 10 sieves (sizes 75mm, 26.5mm, 13.9mm, 9.5mm, 6.7mm, 3.35mm, .7mm, .85mm, .425mm, and .212mm). This follows the methodolgy of Tagart (1976). Gravel quality was also assessed using methology of Tappel and Bjorn (1983). The percent of the sample retained in 9.5mm and .85rmn sieves was examined, and plotted against survival to emergence. The final quality measurement utilized was the "fredle index" (fi), as developed by Lotspeich and Everest (1981).

$$fi = \frac{dg}{S_o}$$

dg = mean geometric diameter of the sample



★ SMOLT TRAP

● FRY TRAP

△ SEINING SITE

□ NILE SPRINGS INCUBATION AND REARING

(DAM

fig, 1 Study sites on the Yakima River

so = sorting index = $\left(\frac{d75}{d25}\right)^{1/2}$ where d_{75} and d25 are grain sizes at the 75th and 25th percentile, respectively. The value for the "fredle index" was regressed against survival to emergence as well.

To determine the number of eggs deposited by each female, a length-fecundity model was generated. One hundred eggs from each of six Yakima River females were weighed. The calculated weight per egg from each fish was applied to the total weight of the remaining eggs from that fish to estimate the fecundity of each individual. Fecundity was regressed against fork length, and a regression model was calculated.

Distribution Studies

Methods followed those described in Wasserman and Hubble (1983). Five seine hauls were made at each of 13 sites on the Yakinm and Naches River each month, Sites are shown in Figure 1. Fry traps were located on the Yakima River approximately 4 miles above its confluence with the Cle Elum River, and on the American River (Fig. 1)

Electro-shocking Surveys

Surveys were conducted during the summer and winter in tributaries of the Naches and Yakima Rivers. A Smith Root Type VII electrofisher was employed to determine upstream utilization of small tributaries. A Smith-Root GPP-5 boat elctro-shocker (Plate II) was used to survey mainstem areas. Catch per unit of effort was calculated as the number of fish captured per minute of electrofishing. In areas where stopnets could be emplaced, density (fish/m^2) was estimated.

Smolt Trapping

Prosser Snolt Trap was operated continuously from March 6 to July 31, 1984, and once per week until the close of the irrigation season in mid-October. Prosser trap operates from a bypass pipe that shunts fish from rotary drum screens in Chandler Canal back to the mainstem Yakima River. In 1984, trapping efficiency (the percentage of migrating fish entering the trap) was calculated via a series of releases of marked fish. The statistical methodology for efficiency calculations was evaluated by Douglas Chapman, University of Washington Center for Quantitative Science. A detailed description of the evaluation process can be found in Appendix A of this

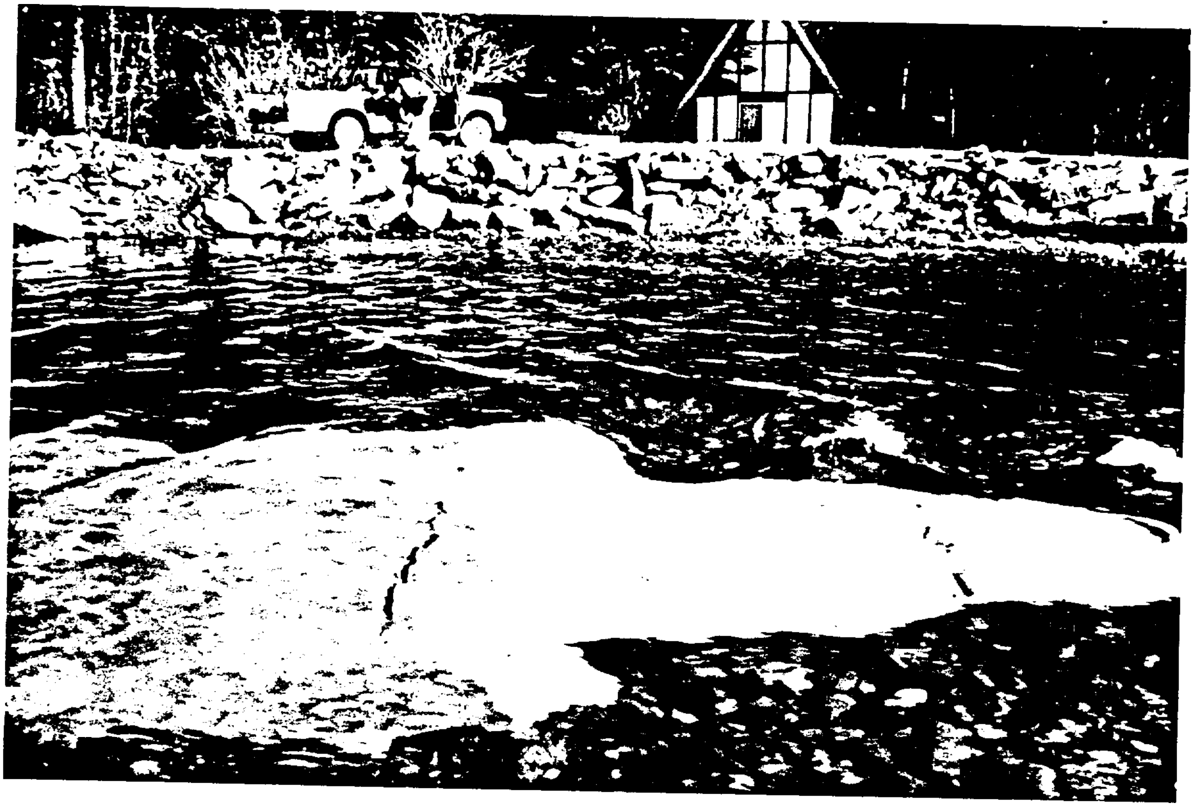


PLATE I. Redd caps were used to measure survival to emergence for spring chinook

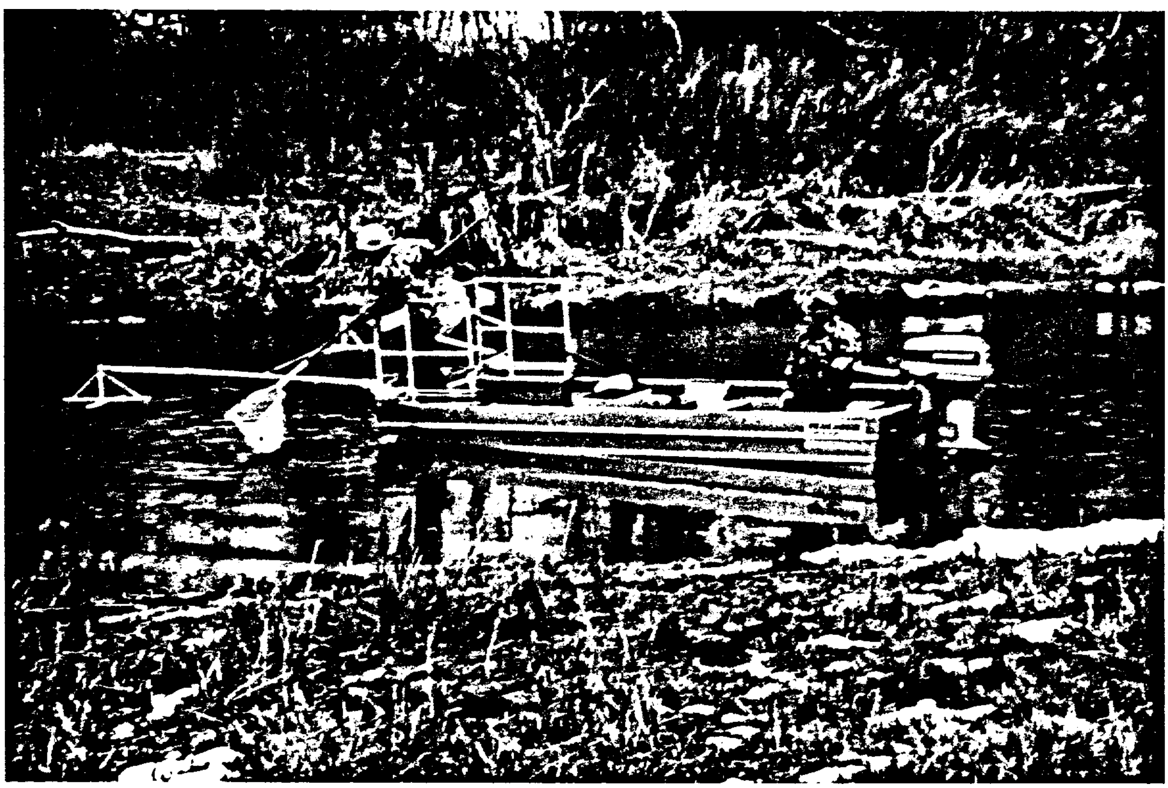


PLATE II. A Smith Root GPP-5 boat shocking unit was used to survey tributary streams manuscript. The basic procedure was as follows. Once each week, fish captured in the trap during the night were cold branded. Two groups were branded differently, with one group released two miles upstream from the canal intake, and a second group released in the canal. Efficiency was calculated based on the recapture rate of branded fish.

$$f_i = \frac{R_{ci}}{R_{ri}} \times \frac{C_{ri}}{C_{ci}}$$

f_i fraction of fish diverted into the canal

R_{ci} = number released directly into the canal in the i^{th} experiment

R_{ri} = number released directly into the river in the i^{th}

C_{ci} = number recaptured from the canal in the i^{th} experiment

C_{ri} = number recaptured from the river in the i^{th} experiment

During the course of the spring chinook smolt migration, 12 experiments were performed, and a relationship was developed between mean weekly flow and efficiency. This relationship was used to estimate the magnitude and timing of the smolt migration through Prosser trap. Two tests using steelhead were performed, and similarity of results indicated that the model for spring chinook could be used for steelhead as well.

Adult Returns

Fish counting stations were monitored at Prosser and Roza Dams in 1984. Counting at Prosser began on May 1 and continued through August. Boza Dam was monitored from May 9 until September 30. Water clarity at Roza Dam was such that fish swimming over the counting board could be visually examined for the presence or absence of an adipose fin.

Spawning ground surveys were begun on the American River in mid-July as part of a coordinated effort between the Yakima Nation, the U.S. Fish and Wildlife Service, Washington Department of Fisheries, and the Bureau of Reclamation. Spawning ground surveys were conducted throughout each reach of spawning area once each week. All carcasses were examined for adipose fins, and fork-length and mid-eye to hypural plate length was measured. Scale samples were taken, and gonads were examined to determine sex, and spawning success. Following examination, the tail of each fish was removed so it would not be examined more than once.

Aerial flights of the Upper Yakima River were made, one each week for three consecutive weeks in late August to document the incidence of spawning prior to September. Historically, spawning in the Upper Yakima River takes place in September and October.

Evauation of Irrigation Screens & Canals in the Yakima Basin

Due to implementation of the Northwest Power Planning Council's Fish and wildlife Program new screens and ladders will be built at all major irrigation diversion dans on the Yakima River. In 1984, losses on Sunnyside irrigation screens (scheduled for replacement in 1984-1985) were enumerated to establish a pre-reconstruction baseline. An individual was stationed at the screens three nights per week from 8:00 p.m.to 8:00 a.m. from May 7 to August 4, 1984. The monitor continually checked the screens and looked for dead fish. All fish found dead on the screens were removed,counted and identified.

Individuals counting adult chinook migrating past Roza Dam noticed many dead juvenile spring chinook at irrigation screens located on the right bank. From June 18th until August 14th, impinged fish were counted at the screens for one hour between 9:00 p.m. and 12:00 p.m. each night.

Mortality was estimated in Chandler Canal as part of the test for trapping efficiency. Branded river-run chinook were released immediately below the in-take of the canal, and 100 meters above the screen. This paired test was done once at night, and once during day light hours. Using the assumption that screens are fish tight, and all fish migrating down the by-pass pipe are captured by the trap, survival was calculated as the number of fish caught divided by the number released.

In addition to these tests, 9 other groups of marked fish were released at the head of the canal during trap efficiency tests. Captures of these fish allowed for estimates of mortality as well.

At the termination of the irrigation season, Roza, Prosser and Sunnyside Canals and Gleed-Selah Canal were electro-fished downstream from the fish screens. A Peterson or DeLury population estimate was made at each sampling site, and losses of fish in the canal was estimated based on the density of fish in the survey area. .

Estimates of Survival Through Various Life Stages

As previously discussed, survival from egg deposition to emergence was investigated. Total egg deposition was calculated as mean fecundity of Yakima River females (based on the length fecundity model) multiplied by the number of redds located on the spawning grounds. Survival from egg to smolt (S_{es}) was calculated as:

S_{es} = estimated number of smolts at Prosser/total egg deposition

The total number of fry produced (F) was calculated as:

F = mean fecundity of Yakima River spawners x number of redds x survival from egg deposition to emergence.

Survival from fry to smolt (S_{fs}) is estimated as:

S_{fs} = F/# of smolts estimated to pass Prosser

Estimates of egg and fry production were made for 1982-1984 based on redd surveys. Survival from egg to smolt and from fry to smolt were based on 1982 redd surveys and 1984 estimates at Prosser.

Part 2:
hatchery Operations
Smolt Releases

To assess the effectiveness of rearing fish in earthen ponds and then allowing for a volitional release as smolts, one group of smolts was released from Nile Springs, as was done in 1983. A second group was transported from Entiat National Fish Hatchery and released directly into the upper Yakima River.

On October 25 and November 1, 1983, a total of 50,000 spring chinook smolts were transported from Entiat Hatchery to Nile Springs Rearing Pond, located on the Naches River. These fish had all previously been coded-wire tagged, and 10% were cold-branded. On March 1 and April 10, 1984 population estimates were made in the pond to determine the total number of remaining fish. Three Peterson estimates (Ricker, 1969) were made each time. A beach seine was passed through the pond, and approximately 1,000 fish were given caudal fin nips. On the following day, the seine was passed through the pond three times, and each time, the number of clipped and unclipped fish were counted.

A volitional release was begun on April 11, and all fish had left the pond within 10 days.

A total of 50,000 spring chinook smolts were transported from Entiat National Fish Hatchery and released into the Upper Yakima River on April 9-12,1984 (Table 1.) All fish were coded-wire tagged and 10% were branded.

Counts of branded hatchery smolts captured at Prosser smolt trap were used to evaluate freshwater survival of both groups of fish. Based on brand recoveries alone the relative survival of each group was calculated. Total estimated passage of each group yielded absolute survival rate estimates to Prosser. Smolt to adult return rates of these two groups will be determined in 1986 and 1987 from captures of tagged fish in the ocean, mainstem Columbia River fisheries, the tribal depnet fishery on the Yakima River, and from carcass recoveries on the spawning grounds.

TABLE 1. Rearing, Marking, and Release Data Of Spring Chinook Smolts Released Into The Yakima River, 1984

Brood Stock	Carson	Carson
Rearing Site	Entiat National Fish Hatchery	Nile Springs*
Rearing Facility	Raceway	Rearing Ponds
Release type	Trucked	Volitional Release
Release Site	Yakim River Ellensburg to Cie Elum	Naches River
Release Date	Apil 9-12, 1984	April 11-18-1984
Number Branded	6,818	4,653
Brand Code	RA7K(1)	RA3T(1)
Number released with AD-WT	41,573	28,450**
Tag Code	5-11-48	5-11-47
Tag Retention	97.7%	96.0%
Size at Release	144mm 25.1/lb	128mm 18.9/lb
Comments	BKD detected in 33.3%	BKD detected in 29.5%

* Fish transported to Nile Springs from Entiat National Fish Hatchery on October 25th and November 11, 1983.

** Number released based on 7 peterson estimates 95% C.I. = 23,347-35,925.

Adult Hatchery Returns

In 1982, 401,714 spring chinook smolts were transported from Leavenworth Hatchery and released into the Yakima River. Of these, 11.3% were coded-wire tagged. Return rates of hatchery adults and jacks to Roza Dam were calculated by visual identification of fish lacking adipose fins passing the counting station. The total number counted was expanded by 8.8 times to estimate total hatchery contribution. In addition, the ratio of tagged to untagged carcasses found on the spawning grounds was calculated. Estimates in 1984 were for four year olds only since this was the first year that fish released in 1982 could return. Jack returns from 1983 release groups were calculated as well.

Pre-smolt Releases

In order to assess the optimum timing of spring chinook releases into the Yakima River, 100,000 fingerlings were released into the Yakima River from RM 152-190 in June, September, and November, 1984. 1983 brood spring chinook were reared at Leavenworth Fish Hatchery, trucked to the Yakima River as fingerlings and scatter planted at 12 sites in the upper river. All fish were coded-wire tagged, and 10% were branded. Brand retention was poor (<2%) on the group released in September, so fish scheduled for release as fingerlings in Novmeber and as smotls in April, 1985 were rebranded on September 26, 1984. Release data is presented in Table 2.

Brood Stock Evaluations

In the years 1950 to 1984 hatchery spring chinook introduced into the Yakima River have come from numerous sources and stocks. An experimental brood stock program was undertaken in 1984 to evaluate the benefits of using spring chinook from the Yakima River as a source of gametes. The purpose was to permit the propagation of fish native to the basin, thereby maintaining the genetic components indigenous to the Yakima River.

The intent of this investigation was to compare four different release groups: (1) Yakima River males crossed with Leavenworth Hatchery (Carson

TABLE 2. Rearing, Marking, and RElease Data or Spring Chinook Fingerlings Into The Yakima River June - September, 1984

Brood Stock	Carson	Carson	Carson
Rearing Site	Leavenworth N.F.H.	Leavenworth N.F.H.	Leavenworth N.F.H.
Release Type	Trucked	Trucked	Trucked
Release Site	Upper Yakima River	Upper Yakima River	Upper Yakima River
Release Data	June 5-6, 1984	September ll-12,1984	November 6-7,1984
Number Branded	8,124	N/A*	11,719
Brand Coue	LA2 (1)	LA2(4)	LAQ(2)**
Number released	102,837	102,833	108,305
Number with Ad-OWT	93,067	93,064	102,229
Tag Retention	90.5%	90.5%	94.4
Tag Code	S-15-28	5-15-29	5-15-30
Size At Release	83mm/66/lb	115mm/25/lb	117mm/21.6/lb

* Brand retention was measured as <2% so brands were considered unreadable

** Fish were originally branded RA2(2) but brand rentention was poor. Fish were rebranded on 9/21/84 ,code = LA2 (2).

Stock) Females, (2) Yakima males crossed with Yakima females, (3) Leavenworth males crossed with Leavenworth females Groups l-3 will be released from an acclimation pond in the upper Yakima River. These groups will be used to determine if cultured fish that are the progeny of Yakima River spring chinook have a greater success in returning to the Yakima River than do non-indigenous stocks. (4) Leavenworth males crossed with Leavenworth Females. This group will be transported from the Hatchery and released directly into the River at Easton. This group will be used as a control to determine the merits of acclimating spring chinook in ponds for 3 to 14 days prior to volitional release. Returns from group four will be compared directly to group three.

Results and Discussion

Survival to Emergence and Substrate Quality Analysis

A total of five redds were successfully capped in February, 1984. The females associated with these redds were captured from September 9 to September 29,1983. (Table 3) The first fry was captured on March 9, 1984 from the trap near Easton (Runacres 110). Median emergence date was quite variable, ranging from April 9th to May 13th. The average number of fry successfully emerging from the gravel was 562. Daily captures of emerging fry are found in Appendix Table Bl.

Emergence was observed to occur over a very short time interval in each redd with approximately 90% of the fry emerging during a ten day period (Figure 2). In addition, those redds located furthest downstream emerged first. Location of redds, in ascending river mile order was Sun Country, Elk Meadows, Runacres 9 and 10 (located adjacent to each other) and Easton. This was precisely the order with regard to timing of emergence.

Thermal requirements for emergence were calculated from temperature recordings taken approximately midway between all capped redds (Table 4). Mean temperature units required for 50% emergence was 1967 and 2291 units were required for 100% emergence. In the case of the redd at Easton a difference of almost 1,000 units was required between the beginning and completion of emergence.

A length-fecundity model was developed based on six Yakima River spring chinook used uor brood stock evaluations (Figure 3).

A statistically significant ($P< .05$ $R = .70$) linear regression model was applied:

$$Y \quad -10856.1 + 19.45X$$

$X=$ fork length in millimeters

$Y=$ number of eggs

Based on this model and from the length measurements of females captured for emergence studies (Table 3) the number of eggs deposited in each redd was calculated. Mean survival from egg deposition to emergence was 20.6%, and

TABLE 3. RESULTS OF YAKIMA RIVER REDD CAPPING 1984

LOCATION	SPAWNING DATE	LENGTH OF FEMALE FORK LENGTH (mm)	ESTIMATED NUMBER* OF EGGS DEPOSITED	NUMBER OF EMERGENT FRY	% SURVIVAL	DATE OF 1ST EMERGENCE	MEDIAN EMERGENCE DATE
Sun Country	09/26/83	682	2,408 (1928)	634	26 3	April 14	April 9
Elk Medows	09/19/83	680	2,369 (1928)	434	18 3	April 1	April 16
Runacres #9	09/29/83	716	3,069 (1549)	399	13 0	April 2	May 6
Runacres #10	09/29/83	736	3,458 (1451)	511	14 8	March 9	May 6
Easton	09/29/83	698	2,719 (1713)	831	30.6	March 12	May 13
mean					20.6		

* Number in parenthesis is 90% prediction interval.

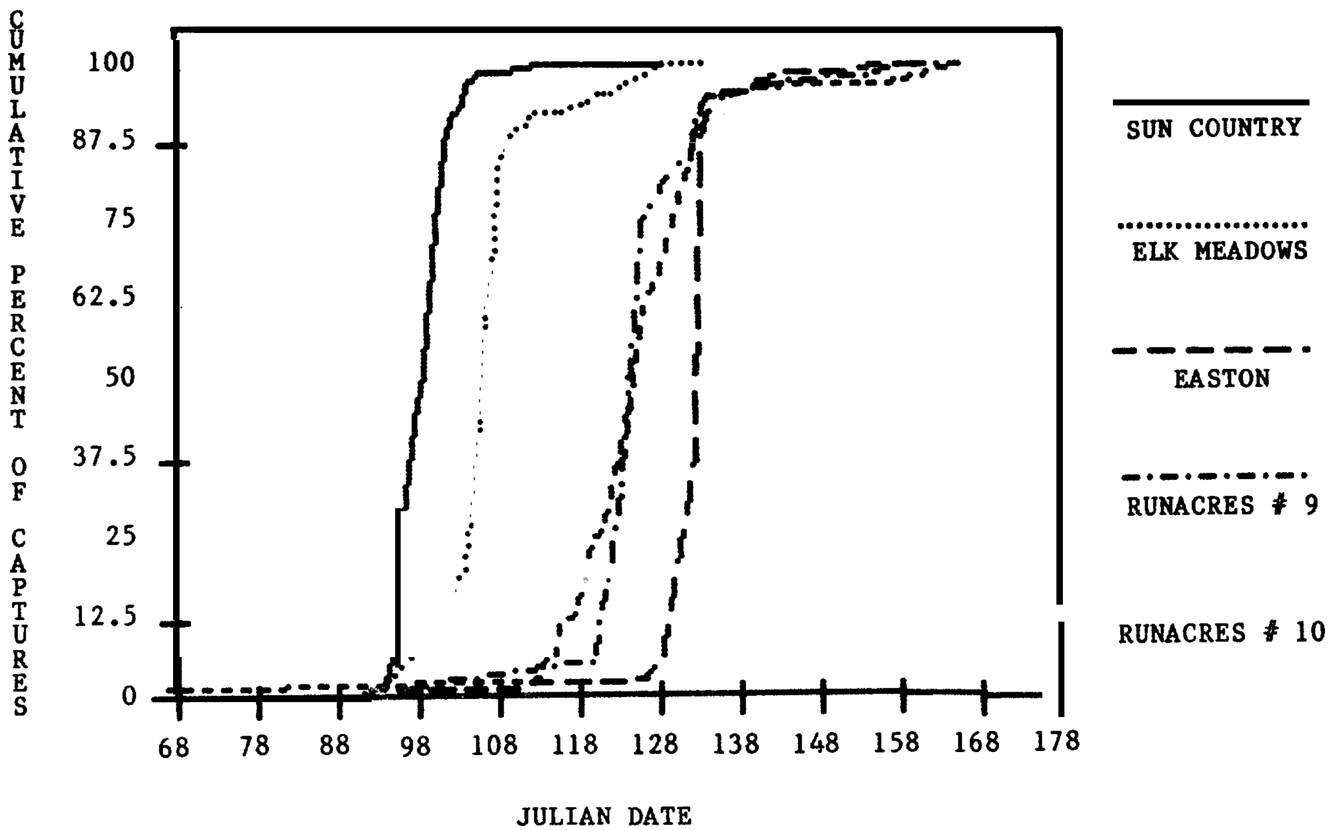


FIGURE 2. EMERGENCE TIMING OF SPRING CHINOOK FROM REDD CAP DATA YAKIMA RIVER, 1984

TABLE 4. **Thermal Unit Requirments For Spring Chinook Emergence, 1984**

Location	Date 1st of Emergence	TU's rquirea	50% Emergence	TU's required	100% Emergence	TU's required
Sun Country	April 4	1687	April 9	1745	May 9	2100
Elk Meadows	April 1	1835	April 16	1986	May 14	2323
Renacres #9	April 2	1824	May 6	2002	June 11	2344
Runacres#10	March 9	1560	May 6	2002	June 14	2344
Easton	March 12	1440	May 13	2099	June14	2344
mean		1669		1967		2291

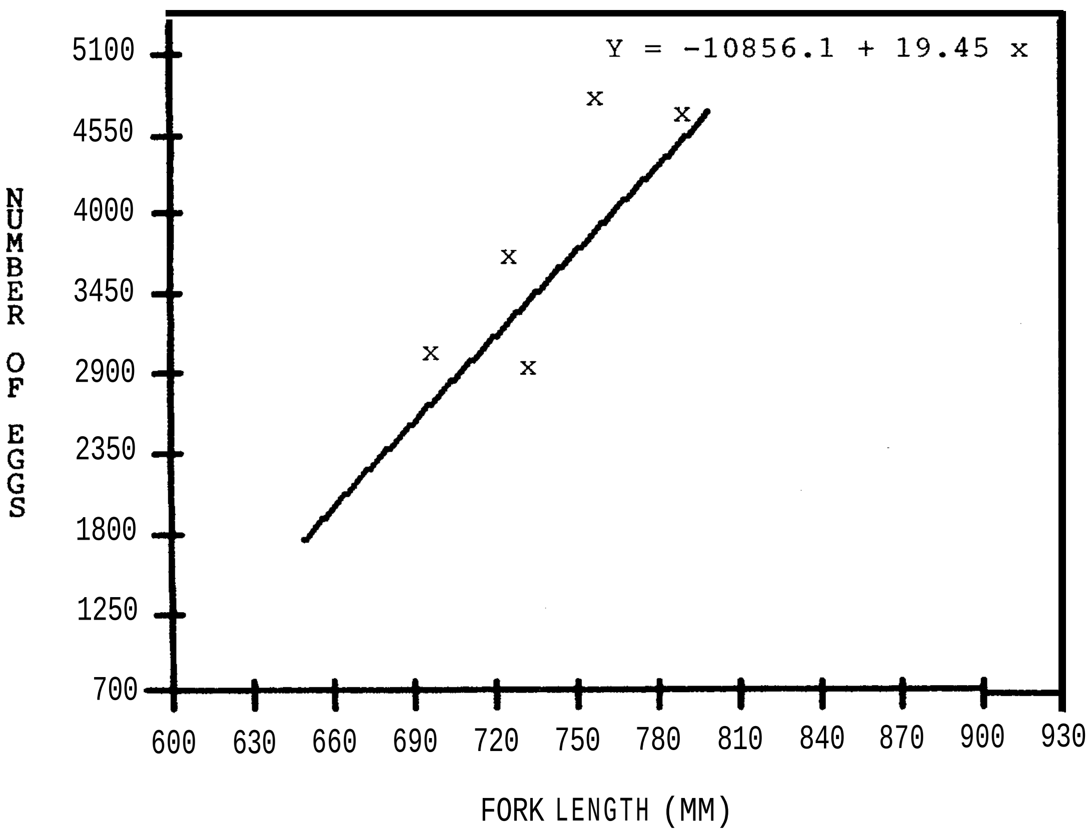


FIGURE 3. LENGTH FECUNDITY RELATIONSHIP OF YAKIMA RIVER SPRING CHINOOK 1984

ranged from 13%-30.6%. Fecundity ranged from 2,369-3,458 eggs. Tagart (1976) showed a mean survival from egg deposition to emergence of 30% for coho salmon. From laboratory studies, Tappel and Bjomn (1983) found survival to emergence to range from 6% to 99% based on the percentage of substrate samples comprised of gravel smaller than 9.5mm and smaller than .85mm. However, gravel larger than 25.4mm was excluded from their samples which would tend to elevate estimations of fine gravel. Their data show that survival ranged from 66% to 88% when 10-12% of the gravel was less than .85mm. These values are considerably higher than those estimated in this study.

Results of gravel sampling are presented in Appendix tables B2 and B3. From these values, analysis was undertaken to determine the relationship between "percent finer than" for each sieve size and survival to emergence. No significant relationships were discovered following the methodology of Tappel and Bjornn (1983). NO trend was observed between survival to emergence and percentage of the gravel sample smaller than 9.5mm and .85mm. There was no relationship observed between survival and any single sieve size.

The fredle index, as presented by Lotspeick and Everest (1981), was calculated and data is presented in Table 5. A statistically significant relationship ($P < .05$ $R=.80$) was found between percent survival to emergence and the fredle index calculated for each redd. A model of the relationship is presented graphically in Figure 4. The regression model is:

$$Y=9.269771\ e^{.25363\ X}$$

where Y= percent survival to emergence
X=fredle index

This model can therefore, be used as a predictive tool for estimating survival to emergence in the Yakima basin, based on gravel samples. Additional data points will be entered into the model in the future as the data is gathered.

An additional nine spent females were captured from the Upper Yakima River for ongoing survival to emergence studies in September, 1984. Gravel samples were taken from these sites as well, and redd caps will be installed in February, 1985. Location of these redds and size of females is presented

Table 5. Calculation Of Fredle Index In The Yakima River, 1984

SITE	d_{25}	d_{75}	d_g	SO	fi
Runacres #9	289	35.38	7.01	3.50	2.00
Runacres #10	2.14	30.09	5.24	3.74	1.40
Sun Country	2.88	34.76	6.97	3.47	2.00
Easton	5.30	49.76	12.17	3.06	3.97
Elk Meadows	4.75	47.95	12.20	3.17	3.84

Dg = mean geometric diameter

So = sorting index = $\left(\frac{d_{75}}{d_{25}}\right)^{\frac{1}{2}}$

Fi = fredle index = $\frac{Dg}{SO}$

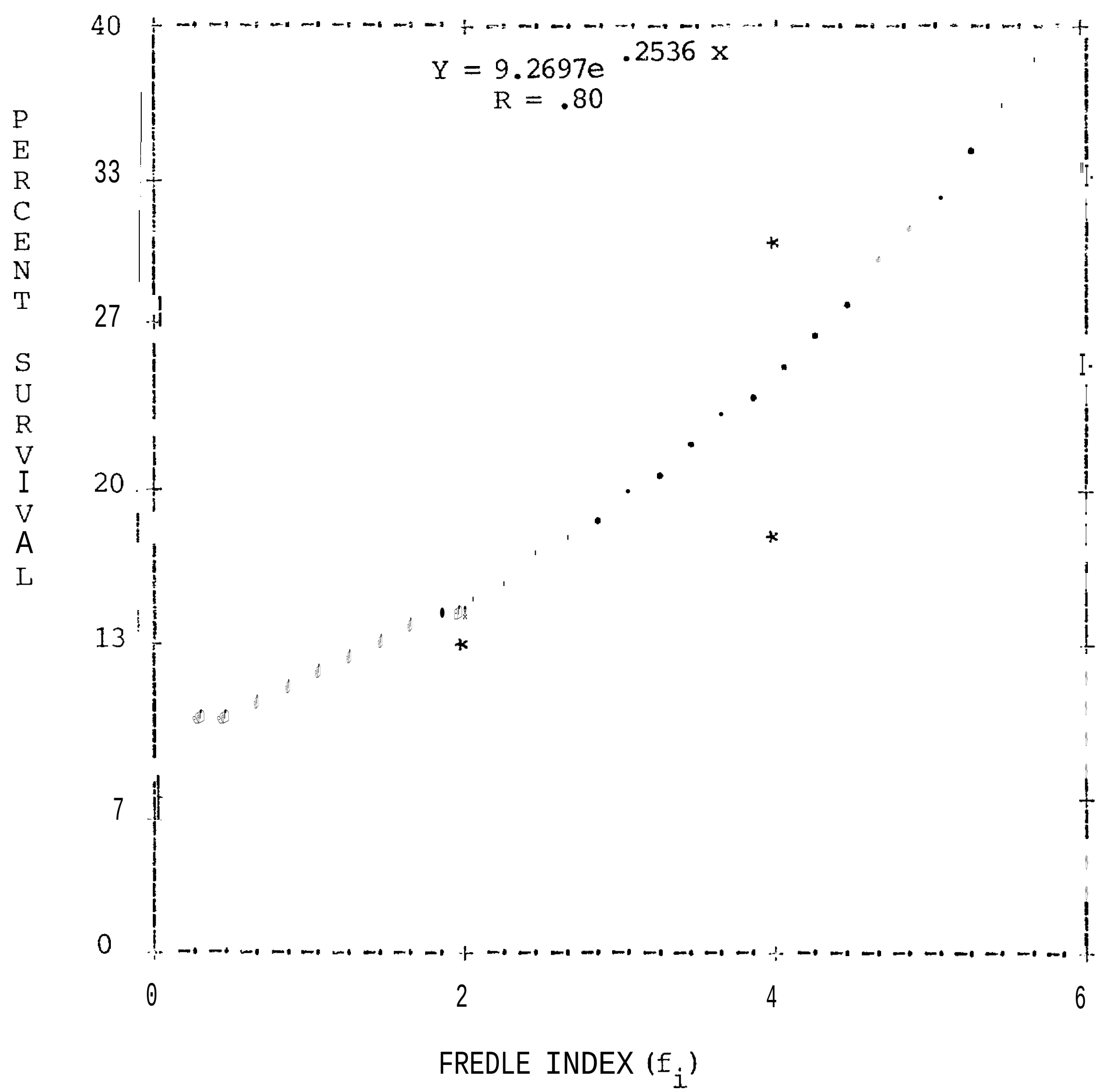


FIGURE 4. SURVIVAL TO EMERGENCE VS FREDLE INDEX FOR YAKIMA RIVER REDDS 1984

in Table 6.

Fry Trapping

Traps were built on the American River at Hell's Crossing and on the Yakima River approximately 4 miles upstream from the confluence of the Cle Elum River. Weekly catch records for the Yakima River trap is presented in Table 7. A total of 207 fish were caught during 124 days of sampling. Mean length of fry captured before June 1st was 35.5mm. Newly emergent fry were caught until May 1 (Julian date 121) and the size of fish captured was identical to the size of fish captured in emergence traps. Figure 5 presents the timing of fry captured at the Yakima River trap in 1984. The median date of capture was April 15. The median date of emergence in redd caps was April 27th. Since the two values are in close agreement, it appears that the peak of emergence occured during the second and third weeks of April in 1984 in the Yakima River.

Fry capture data for the American River trap is presented in Table 8. The size of these fish is similar to that observed in the Yakima River. A total of 784 fish were captured with median date of capture occuring on April 17th. This is two days later than that observed on the Yakima. The close proximity in emergence timing is remarkable in light of the fact that spawning in the American River occurs 6-8 weeks before it peaks in the Upper Yakima System. The similarity in emergence timing is partially the result of water temperatures in the American River which are much colder than those observed in the Upper Yakima River. Therefore, it takes considerably longer to accumulate temperature units in the American River than in the Upper Yakima River. However, there is undoubtedly a genetic component as well that insures that emergence occurs at times most conducive to fry survival.

From April 21st to May l0th, a series of size tests were undertaken at the American River trap to determine trapping efficiency (Table 9). Captured fish were cold-branded and released upstream approximately l/4 mile. Flows remained fairly stable during each recapture period. The mean trap efficiency based on 6 tests was 6.6%. Based on the capture of 784 fry, this yields an estimated fry migration of 11,894.

There were 36 redds counted on the Naches River in 1983. Using the

Table 6. Location of Redds and Size of Females for survival to Emergence studies, September, 1984

Location	Date Captured	Fork Length(mm)	ME-HP(mm) *
Easton Ridge 1	9/24/84	680	590
Easton Ridge 2	9/24/84	620	565
Easton Ridge 3	9/24/84	705	580
Elk Meadows	9/25/84	737	603
Bullfrog 1	9/26/84	730	600
Bullfrog 2	9/26/84	680	570
Sun Country 1	9/27/84	710	650
Sun Country 2	9/27/84	760	700
West Nelson	9/28/84	680	630

* ME-HP = mid-eye to hypural plate Length

Table 7. Yakima River Fry Trap Captures, 1984

Month	Julian Date	Number Captured	Mean Length (mm)	Number of Days Trap was operable
	41-45	0		5
	46-50	0		5
	51-55	0		5
	56-60	0		5
March	61-65	0		5
	66-70	19	35	5
	71-75	3		5
	76-80	2	35	5
	81-85	14	35	1
	86-90	12	35	5
April	01-95	24	36	5
	96-100	17	36	5
	101-105	18	36	5
	106-110	46	36	5
	111-115	34	36	5
	116-120	11	35	4
	121-125	34	34	5
IMay	126-130	0	0	5
	131-135	0	0	5
	136-140	0	0	5
	141-145	0	0	5
	146-150	0	0	4
June	151-155	1	41	2
	155-160	1	50	5
	161-165	1	84	5
	TOTAL	207		

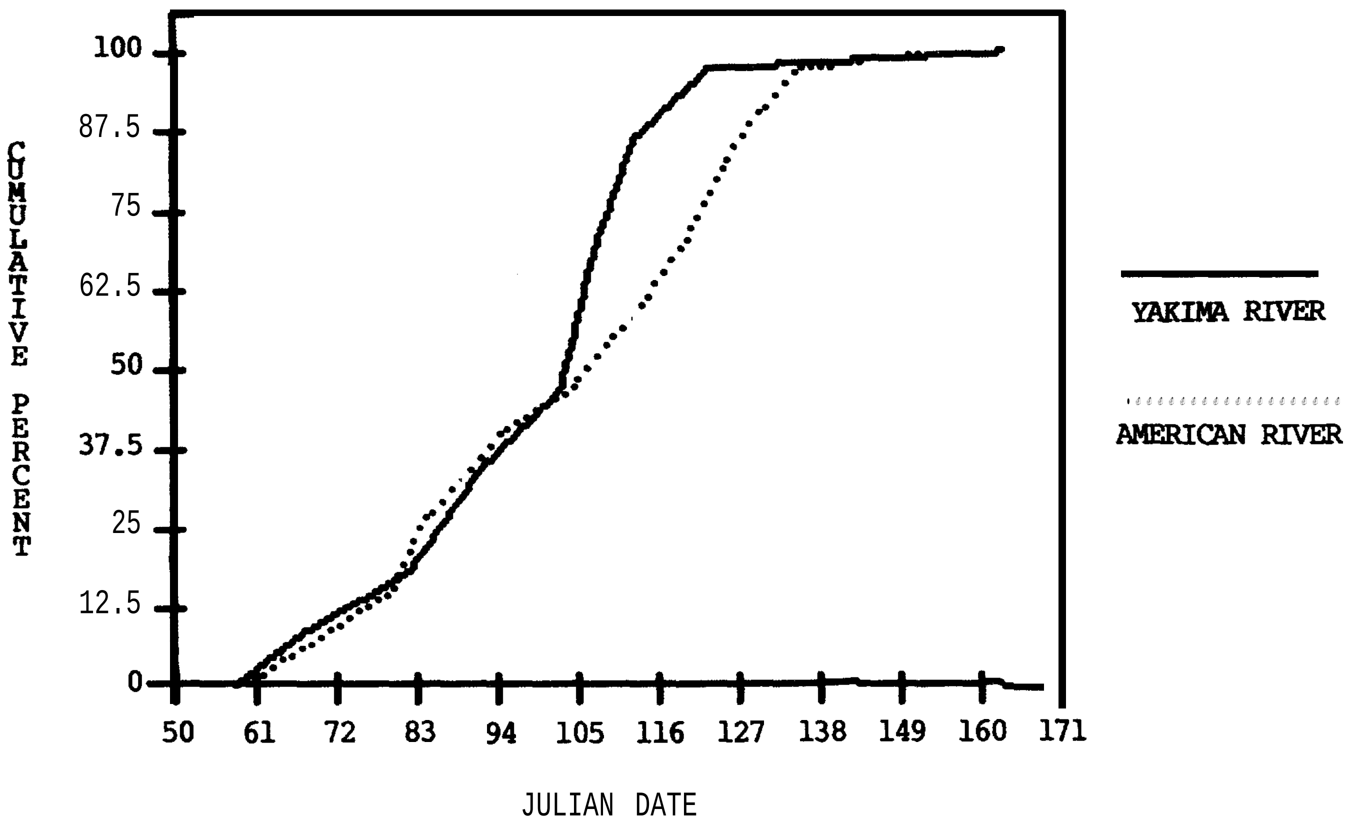


FIGURE 5. TIMINGOFFRY CAPTURES AT AMERICAN AND YAKIMA RIVER FRY TRAPS 1984

Table a. American River Fry Trap captures, 1984

Month	Julian Date	Number Captures	Mean Length (mm)	Number Of Days Trap Was Operable
	38-42	0		5
	43-47	1	30	5
	48-52	0		5
	53-57	0		5
	58-62	0		5
March	63-67	0		5
	68-72	0		5
	73-77	0		5
	78-82	130	35	5
	83-87	90	36	5
	88-92	73	35	5
April	93-97	32	35	5
	98-102	12	35	5
	103-107	44	36	5
	108-112	57	36	5
	113-117	50	37	5
	118-122	71	38	5
May	123-127	80		5
	128-132	71	38	5
	133-137	58	38	5
	138-142	5		5
	143-147	5	41	5
	148-152	2	40	2
June	153-156	4	40	0
	Total	784		

Table 9. American River Efficiency Tests, 1984

Release Date	Number Released	Number Recaptured	Flow range (cfs)	% Recaptured
3/21/84	13	1	269-275	7.7
4/2/84	19	1	186-197	5.3
4/8/84	18	1	165-217	5.6
4/25/84	64	5	188-207	7.8
5/1/84	76	4	198-249	5.3
5/10/84	74	6	246-456	8.1
				mean = 6.6

previously mentioned length-fecundity model, and mean fork-length for Naches females of 85.4mm, mean fecundity was 5754 eggs. This results in an estimated deposition of 207,144 eggs. If the survival to emergence data developed from the Yakima River is applied to the American River a 20.6% survival rate from deposition to emergence yields 42,672 emergent fry. Therefore, 28% (11894/42672) of the newly emergent fry in the American River move down stream immediately after emergence. This number will be verified more precisely when redd capping studies are conducted in 1985 on the American River.

Due to higher, more variable flows in the Yakima River, and the limited area encompassed by the trap relative to the entire stream cross section, efficiency tests were not possible for the Yakima River trap in 1984. Mean monthly flows during March through June ranged from 1023-4414 cfs at this location (Table 10.)

Distribution Studies

Beach seining was conducted at 13 sites throughout the Yakima River (Figure 1). Seining was unsuccessful from December through February at most sites due to cold weather. In December and January, cold air temperatures and anchor ice precluded sampling. High water made sampling in June impossible as well.

Monthly capture data is found in Figure 6. The ordinate depicts captures per five seine hauls. Fisher were captured as far downstream as river-mile 95 in December. In March, fish were found from Prosser (rm 44) to the Yakima Canyon, but high water made sampling in the lower river impossible. In April, fish were found throughout the basin, but fish above rm 135 were predominantly newly emerged fry, while only smolts were found lower downstream. The profile for May is similar to that observed in April. I. July, August, and September, as in 1983, most fish were captured in the Yakima Canyon, with some fish found upstream, and very few captured below Selah (rm 118). Few fish were captured throughout the basin in October, probably due to the onset of colder water and behavior changes of the fish.

Figure 7 presents seasonal beach seine captures throughout the Yakima River. During the spring (March-May) fish were found distributed throughout

Table 10. Mean monthly flows (cfs) throughtout the Yakima Basin January-SEptember, 1984.

Month	Easton	Cle Elum	Parker	Prosser	Kiona	Naches River	American River
Jan.	797	2009	6676	7795	7559	2141	449
Feb.	514	939	4509	3578	5442	1780	175
Mar.	525	1023	4325	3565	5436	1833	187
Apr.	602	1034	2255	2083	3830	1465	196
May	821	2602	2827	2712	4183	2611	392
June	1067	4414	5641	6027	7339	4396	655
July	275	3184	890	1010	2214	1695	382
Aug.	235	3924	382	369	1547	405	98
Sept.	273	1163	469	790	2080	1409	57
Oct.	215	495	1026	1700	2560	814	N/A

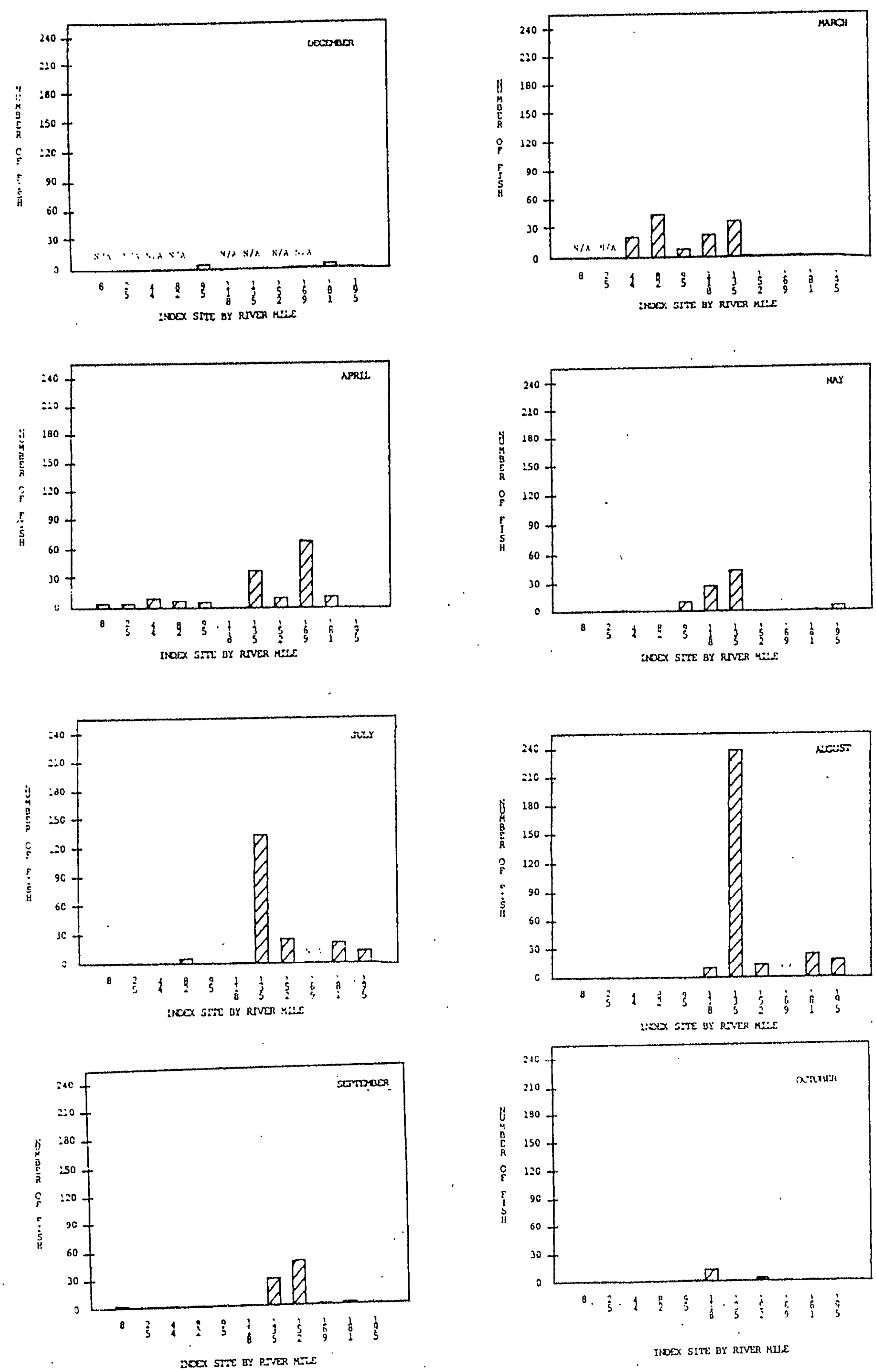


FIGURE 6. MONTHLY BEACH SEINE CAPTURES IN THE YAKIMA RIVER, 1984

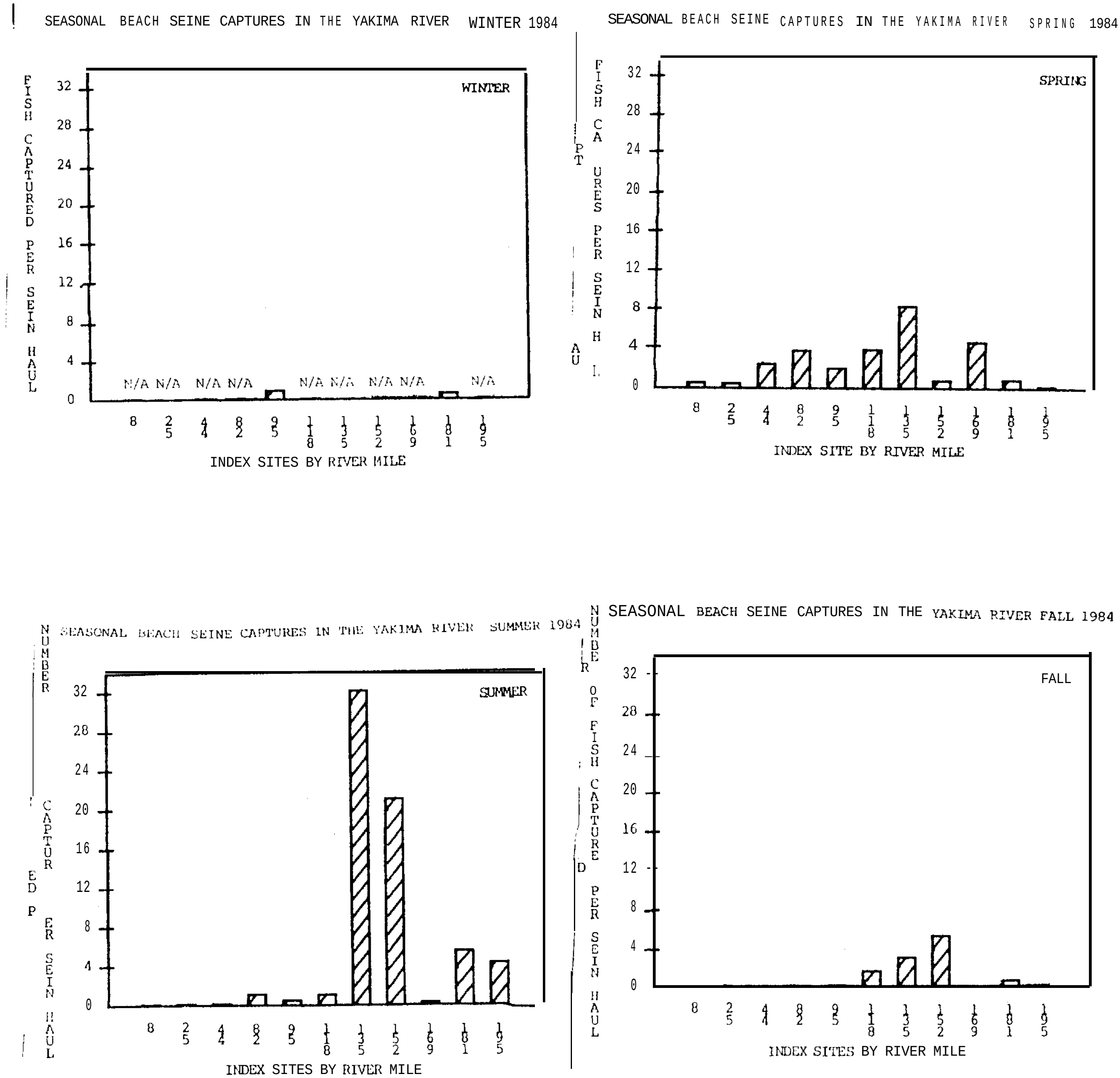


FIGURE 7. SEASONAL BEACH SEINE CAPTURES IN THE YAKIMA RIVER, 1984

the basin, with the highest concentration in the Yakima Canyon, (rm 135), although substantial numbers were found at Granger (rm 82) and in the Ellensburg Canyon (rm 169). During the summer months (June through August) few fish were captured below Selah (rm 118), and again, the fish were most concentrated in the Ellensburg to Yakima Canyon area. During the fall (September and October) most of the fish were still captured in the Yakima Canyon. The lower capture rate is probably due in part to the cooling water temperatures and the decreased ability to capture fish as they burrow into the substrate.

In the Naches River, few fish were captured in the upper watershed in the spring (Figure 8.). Data from a fry trap on the American River indicate a mean emergence date of April 15th and there was little spawning in the Naches River above RM 42, which would indicate that fry migrating from spawning areas in the American River during the spring remain in the Upper Naches River (above the seining site) or in the lower American River. During the summer months, relatively large numbers of fry were captured in the middle and upper Naches River, no doubt due to outmigration of fingerlings from the American River. This same trend was observed during the fall. As in 1983, a general trend of downstream movement of fingerlings from upstream spawning areas was observed, with few fish captured in the lower Naches River during the fall months.

In an effort to determine the timing of the smolt migration out of the Naches River, areas near RM 9 were beach seined periodically from March through May (Figure 9) Peak smolt migration estimated from this analysis occurred in mid-May. However, this area was sampled only once in April due to high water, and fish from the Naches River may have entered the mainstem Yakima River earlier than our first sapling date. Fry were captured at this site as early as April 24th, indicating a mov ment of spring chinook out of this system soon after emergence.

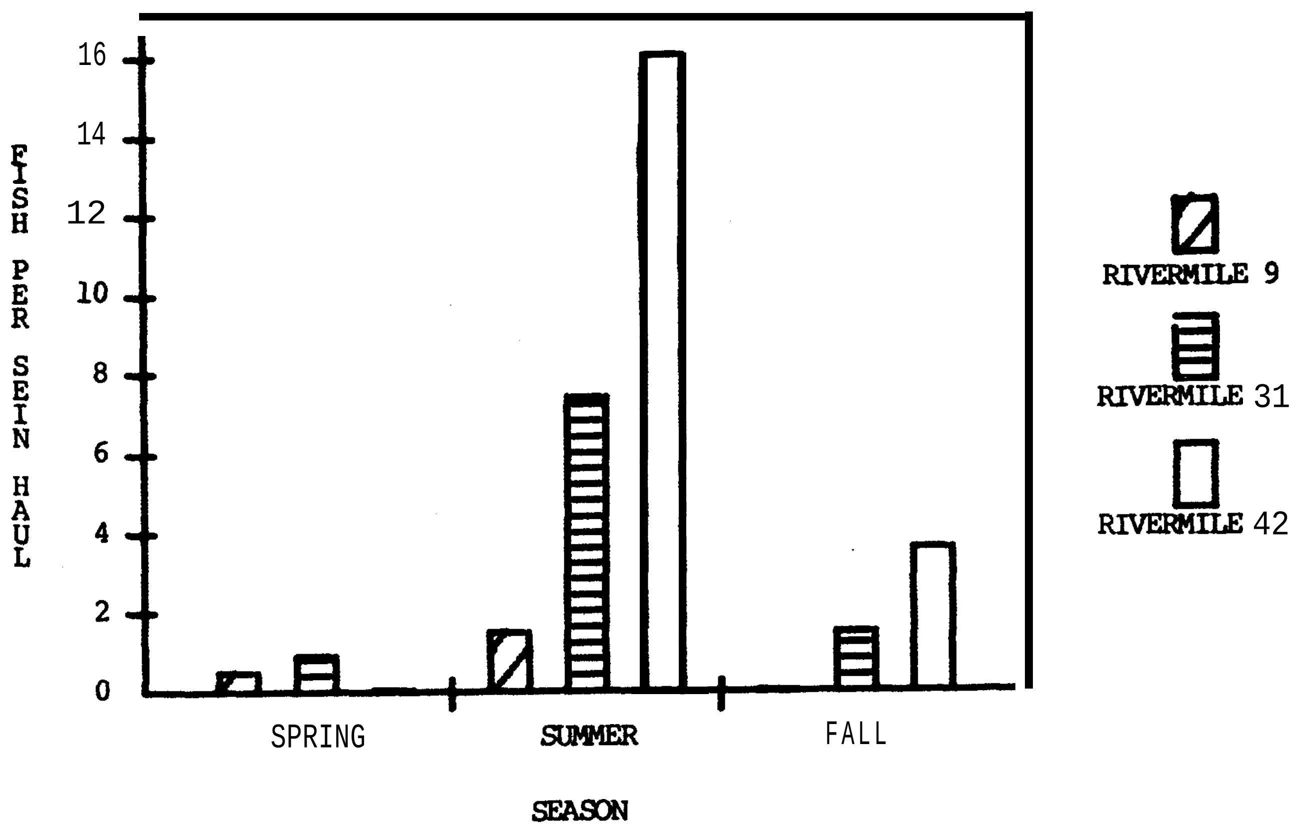


FIGURE 8. SEASONAL BEACH SEINE CAPTURES IN THE NACHES RIVER 1984

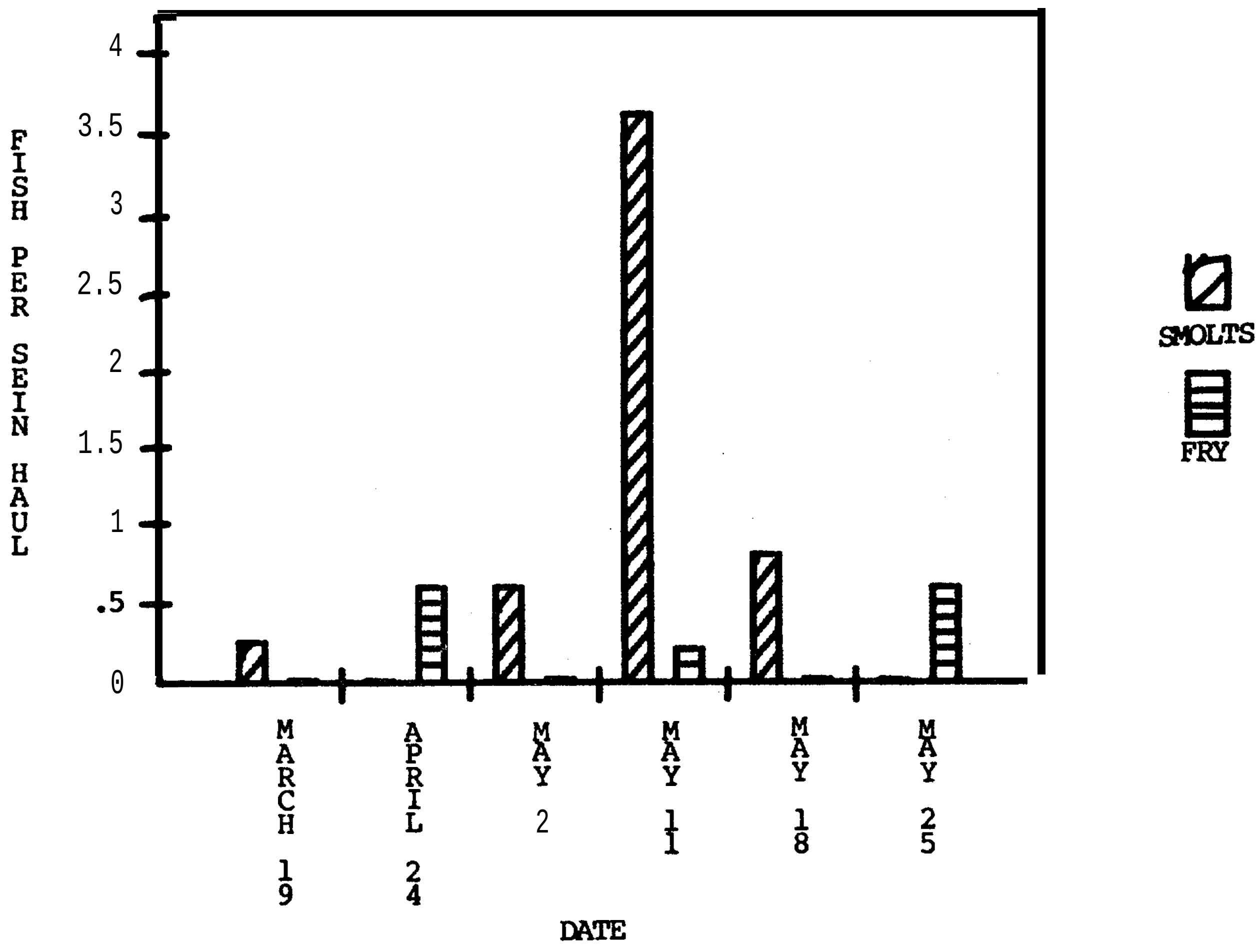


FIGURE 9. CAPTURES OF SMOLTS AND FRY IN THE LOWER NACHES RIVER (RM 9) SPRING 1984

Electroshocking Surveys

Electroshocking surveys were undertaken throughout the Yakima River from December, 1983 to August, 1984 to document utilization of tributary streams for winter and summer rearing of juvenile spring chinook. During the winter months, fish were captured throughout the basin as far downstream as rm 8.0 (Table 11). Since no chinook were caught this far downstream during beach seining through November, this suggests that they move downstream sometime after early November. Chinook fry were captured throughout the upper watershed in May and June, but no fish were caught at rm 8.0 when it was surveyed on May 16th. Spring Chinook were found residing in side channels and side pools as well as in the mainstem in both the Yakima and Naches Rivers. A population estimate was made in the American River in August, 1984. A distance of 167 meters was electrofished and a density of 1.70 $fish/m^2$ was estimated.

Tributaries were inventoried during the winter of 1983 and summer of 1984. (Table 12). No chinook were found in Cabin Creek (above Easton Dam), Wenas, Ahtanum, or Satus Creeks or in Wanity Slough. No chinook were captured in Little Creek in 1984, although fish were found at rm .3 in August, 1983. Fish were captured in Swauk Creek during the summers of 1983 and 1984, up to rm .8 but none were found during the winter months of 1983. In Manastash Creek juvenile spring chinook were captured 1.4 miles upstream from its Yakima River confluence in August. The fact that fingerlings were found upstream in Manastash Creek during the summer (when flows are drastically reduced) would suggest that fish do not migrate upstream as juveniles, but rather that spawning does take place in this Yakima River tributary stream. This is the first documentation in recent history of spring chinook spawning or rearing in Manastash Creek. Fish were found near the mouth of Umptanum Creek for the first time during the summer of 1984, but none were captured during the winter. In wide Hollow Creek, 19 fish were captured at rm .9 on January 18, 1984, but none were captured during a survey in August. Therefore it appears that although Wide Hollow Creek is not utilized for rearing during the summer months (probably due to excessively warm water temperatures) it does provide

Table ll. Summary of electroshocking data for spring chinook in the Yakima and Naches River Systems, Dee/83 to Aug/84.

River	Sample Date	R.M.	Shocking	chinook/ M2	Avg. Length (mm) x	sd	n	Habitat
Yakim	5-7	201.8	3.20 A	—	39	4.8	39	SC
"	6-11	201.8	0.20 a	—	52	9.6	6	SC
"	5-22	182.0	0.93 b	—	46	8.4	9	SC
"	5-22	182.0	3.30 b	—	42	2.7	28	SC
"	5-22	182.0	2.90 b	—	46	5.0	37	sp
"	5-23	152.0	2.00 b	—	45	5.3	39	ms
"	1-10	100.0	0.75 b	<.01	107	12.5	20	SC
"	2-22	90.0	0.00 b	—	—	- -	—	ms
"	1-11	83.5	0.00 b	—	- -	- -	—	sp
"	1-11	83.7	1.10 b	—	113	7.0	22	SC
"	1-11	84.7	<.01 b	—	—	- -	—	SC
"	1-11	85.5	0.00 b	—	—	- -	—	sp
"	12-19	82.0	0.00 b	—	—	- -	—	ms
"	2-27	25.0	0.51 b	—	109	10.1	43	ms
"	5-16	8.0	0.00 b	—	- -	- -	—	lns
American	8-2	7.3	0.65 a	1.70	60	10.6	126	ms
Naches	5-11	12.6	0.28 a	—	53	10.9	8	ms
Naches	5-18	12.7	1.92 a	—	41	5.1	31	sp
Naches	5-25	12.7	2.02 a	—	43	6.0	16	sp

sc= side channel ms= mainstem sp= side pool(off mainstem)
a= sampled with Type-VII Smith-Root backpack electroshocker.
b= sampled with Smith-Root GPP-5 boat electroshocker.

Table 12. Summary of electroshocking data for spring chinook in tributaries of the Yakima River, Dec/83 to Aug/84.

Stream	Date	Conf.* R.M.	R.M.	CPUE fish/min	Meters Shocked	Fish/M2	Avg. Length (mm) x	sd	n
Cabin	7-31	205	2.4	0.00	150	—	—	—	—
Tucker	5-15	200	0.1	--	119	0.07 (.06-.08)	41	6.0	24
Big	7-17	196	0.1	0.05	127	—	72	10.6	2
Little	7-2	195	0.7	0.00	61	—	—	—	—
Little	7-17	195	1.5	0.00	168	—	—	—	—
Squaw	1-17	135	0.1	0.00	50		—	—	—
Swauk	8-l	170	0.3	0.03	172	==	—	—	—
Swauk	8-2	170	0.8	0.13	128	0.02 (.01-.03)	82	11.5	11
Swauk	8-29	170	4.5	0.00	196	—	—	—	—
Taneum	8-3	166	0.1	0.07	83	—	83	7.8	2
Manastash	7-26	155	0.7	0.11	78	0.04 (.02-.06)	83	5.7	11
Manastash	7-30	155	0.5	0.17	265	0.04 (.03-.05)	81	7.9	25
Manastash	8-15	155	1.4	0.03	203	—	103	2.1	2
Umptanum	1-17	140	0.1	0.00	50	—	—	—	—
Umptanum	1-17	140	0.3	0.00	60	—	--	—	—
Umptanum	6-12	140	0.1	0.05	80	—	—	—	—
Wenas	5-6	122	0.1	0.00	98	--	—	—	—
WD Hollow	1-18	107	0.9	0.49	91	—	122	12.1	19
WD Hollow	8-21	107	0.9	0.00	70	—	—	—	--
Ahtanum	1-18	107	1.0	0.00	80	—	—	—	—
Ahtanum	8-21	107	1.0	0.00	80	—	—	—	—
Wanity	1-11	86	0.1	0.00	- -	—	—	—	—
Satus	12-20	70	0.1	0.00	- -	—	—	—	—

sc= side channel ms= mainstem sp= sidepool (of f mainstem)
* Confluence with Yakima River
WD Hollow = Wide Hollow Creek

winter habitat for spring chinook.

Smolt Captures At Prosser Trap

Trapping began at Prosser Trap on March 6, and continued intermittently until March 19th. At that time, trapping was conducted continuously until July 31st. Weekly captures are reported in Table 13. wild spring chinook captures totaled 59,365. Captures of wild steelhead and wild fall chinook were 35,365 and 52,189 respectively. Table 14 presents estimated passage of spring chinook from the Yakima Basin. From Marcxh 5th to June 30th, 178,214 spring chinook smolts passed Prosser Dam. On the first day of trapping 3 fish were captured indicating some movement had occurred before trapping began. On April 27th (Julian date 118), 50% of the wild spring chinook smotls had passed Prosser (Figure 10) and by May 13th, 75% of the run had passed.

From the 70,023 hatchery spring chinook smolts released into the basin in April, 1984, 10,297 were captured, which yielded an estimated migration of 26,162 (Table 14). There were 6,818 branded fish transported and released into the Yakima River, and 2,916 of these were estimated to have passed Prosser. A total of 4,653 branded fish were released from Nile Springs, of which 3,088 passed Prosser. On June 6-7, 1984, 102,837 fingerlings were released into the upper Yakima River and by July 31, 30,343 were estimated to have passed Prosser. Daily captures of fish can by found in Appendix Tables B.5-B.9 and daily passage estimates are found in Appendix Tables B.10-B.18.

Run timing of hatchery smolts is presented in Figure 10. The run is somewhat later than that observed for wild fish largely because fish were not released until April 9th (Julian date 120). There was a 13 day difference in timing between fish released from Nile Springs and those released into the YakimaRiver. The distance from Nile Springs, and the median release point of fish in the upper Yakima River to Prosser is 98 and 118 miles, respectively. Median release date of transported fish was April 10th and median capture date was May 14th Therefore, fish migrated 118 miles in 34 days, for an average rate of 3.5 miles per day. Median release date from Mile Springs was April 15th, and median capture date was May lst, yielding a migration rate of 6.1 miles per day. By May 20th, 75% of the migration of each group was

TABLE 13. WEEKLY CAPTURES AT PROSSER SMOLT TRAP, 1984

DATE	WILD SPRING CHINOOK	HATCHERY SPRING CHINOOK	NILE SPRINGS	TRANSPORTED	HATCHERY SPRING CHINOOK FINGERLINGS	WILD STEELHEAD	HATCHERY STEELHEAD	WILD FALL CHINOOK	HATCHERY FALL CHINOOK	COHO
3/5-3/7	9					3				
3/8-3/14										
3/15-3/21	34					40				
3/22-3/31	445					540				
4/1-4/7	3432					962				
4/8-4/14	3841					1435				
4/15-4/21	12629	405	50	11		5396	812			
4/22-4/30	11437	1844	466	220		6220	2967			
5/1-5/7	9296	3243	469	167		8729	1846			11
5/8-5/14	4891	2236	331	210						56
5/15-5/21	817	2474	227	352		3697	673	1929		35
5/22-5/31	4171	91	3	5		1255	42	2563		37
6/1-6/7	755	0	3	5		492	43	1353		13
6/8-6/14	162	3		1		48		846		0
6/15-6/21	113	1				36	3	351	2	2
6/22-6/30	3				50			111	135	0
7/1-7/7					2646			205	7441	
7/8-7/14					1997			401	5548	
7/15-7/21					1101			202	2413	
7/22-7/31					546			107	578	
TOTAL	59365	10297	1549	966	6140	35144	7362	9078	16117	154

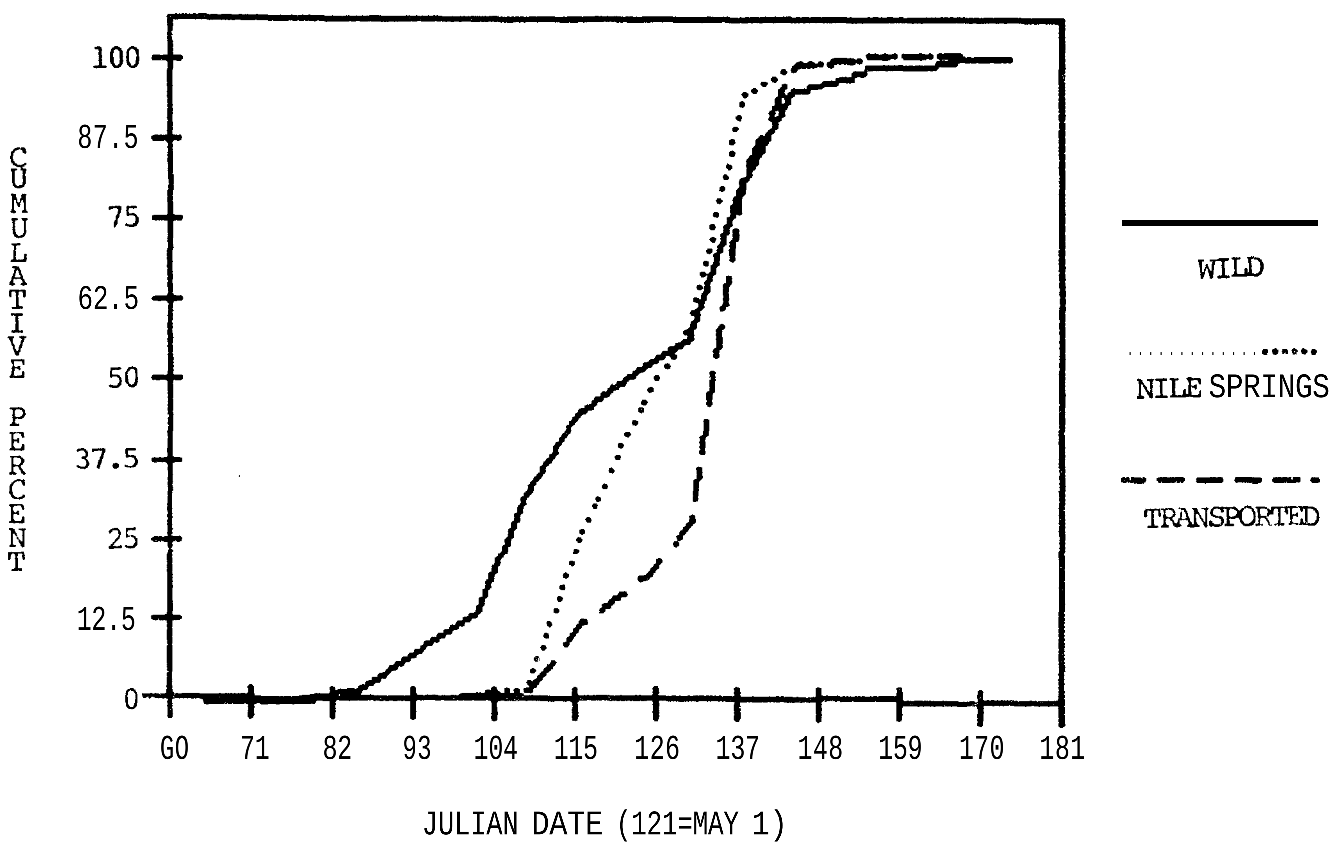


FIGURE 10. RUN TIMING OF HATCHERY AND WILD SPRING CHINOOK SMOLTS AT PROSSER 1984

TABLE 15. ESTIMATED NUMBER OF STEELHEAD, FALL CHINOOK, AND COHO SMOLTS PASSING PROSSER, 1984

JULIAN DATE	WILD STEELHEAD	HATCHERY STEELHEAD	COHO	WILD FALL CHINOOK	HATCHERY FALL CHINOOK
(61-67) 3/1-3/7	24 (11-55)				
(68-74) 3/8-3/14	67 (41-107)				
(75-81) 3/15-3/21	286 (181-449)				
(82-91) 3/22-3/31	4800 (2457-9392)				
(92-98) 4/1-4/7	5230 (3228-8526)				
(99-105) 4/8-4/14	4326 (3107-6030)				
(106-112) 4/15-4/21	13266 (9637-182157)	2163 (1576-2973)			
(113-121) 4/22-4/30	15001 (10729-20983)	7566 (5433-10537)			
(122-128) 5/1-5/7	11903 (8729-18453)	2526 (1846-3912)	14 (11-22)		
(129-135) 5/8-5/14	7576 (6291-12368)	1245 (1016-2017)	66 (56-108)	1222 (1021-1997)	
(136-142) 5/15-5/21	10792 (7188-16282)	1617 (1120-2342)	144 (93-221)	6638 (4364-10153)	
(143-152) 5/22-5/31	9576 (5250-17494)	309 (170-566)	290 (156-539)	19104 (10575-34575)	
(153-159) 6/1-6/7	3427 (1946-6017)	287 (165-500)	92 (50-165)	9373 (5337-16424)	
(160-166) 6/8-6/14	426 (216-838)	- - -	- - -	7871 (3973-15620)	
(167-173) 6/15-6/21	337 (167-675)	32 (17-14)	17 (9-34)	3338 (1667-6676)	24 (10-52)
(174-182) 6/22-6/30	- - -	- - -	- - -	1624 (647-4045)	2485 (930-6606)
(183-189) 7/1-7/7	232 (113-476)			2043 (971-4393)	58468 (30797-113399)
(190-196) 7/8-7/14	6 (6-6)			688 (537-920)	8180 (6679-11369)
(197-203) 7/15-7/21	2 (2-2)			202 (202-202)	2447 (2413-2447)
(204-213) 7/22-7/31	- - -			106 (106-106)	582 (578-582)
T O T A L	87277 (59299-136410)	15745 (11340-22916)	623 (375-1089)	52189 (29400-95111)	72186 (41397-134455)

*Numbers in parenthesis are 90% confidence limits completed, and 99% of the migration had passed by the end of May.

Al2 day difference was observed in run timing of hatchery smolts to McNary Dam (Figure 11) located 90 miles from Prosser. The median capture date of transported fish, and those from Nile Springs was May 22nd and May 14th respectively. However, the average number of miles per day traveled by these two groups of fish from Prosser to McNary Dam was 11.25 for the transported fish and 6.9 for the Nile Springs fish. Therefore, it appears that the fish from Nile Springs maintained a constant rate of travel during their outmigration, while the rate calculated for transported fish increased after they left Prosser. The large pool behind Roza Dam in the upper Yakima River is probably a factor in initially decreasing the migration rate.

For fingerlings released into the upper watershed in June, 1984, the median date of capture at Prosser was July 4th (Figure 12). The first fish was captured at Prosser on June 29th and few fish were captured after the end of July. Therefore, there was a large movement out of the basin of fingerlings that were released in June. In addition, those fish remained in the release area for only a short period of time, since the capture date was less than one month after release. Daily captures at Prosser are found in Appendix Table B.19.

Estimated passage of smolts other than hatchery reared spring chinook is presented in Table 15. As in 1983, spring and fall chinook were differentiated based on length frequency histograms (Figure 13). The two nodes observed in May illustrate the delineation between the two groups. It was estimated that 52,189 wild fall chinook smolts migrated past Prosser. On June 15th 103,722 hatchery fall chinook, with clipped adipose fins and coded wire tags were released. 72,186 (69.6%) were estimated to have passed Prosser . Run timing is presented in Figure 14.

A total of 87,269 wild steelhead smolts ere estimated to have passed Prosser Dam in 1984. In addition, 49,288 steelhead (8/lb) were released from Nelson Spring Rearing Ponds by the Yakima Chapter of the Northwest Steelheaders on April 17th. From this release 15,745 (32%) were estimated to have migrated past Prosser from April 20th to June 21st. Run timing is presented in Figure 15.

In 1984, survival to Prosser for fish released from Nile Springs and

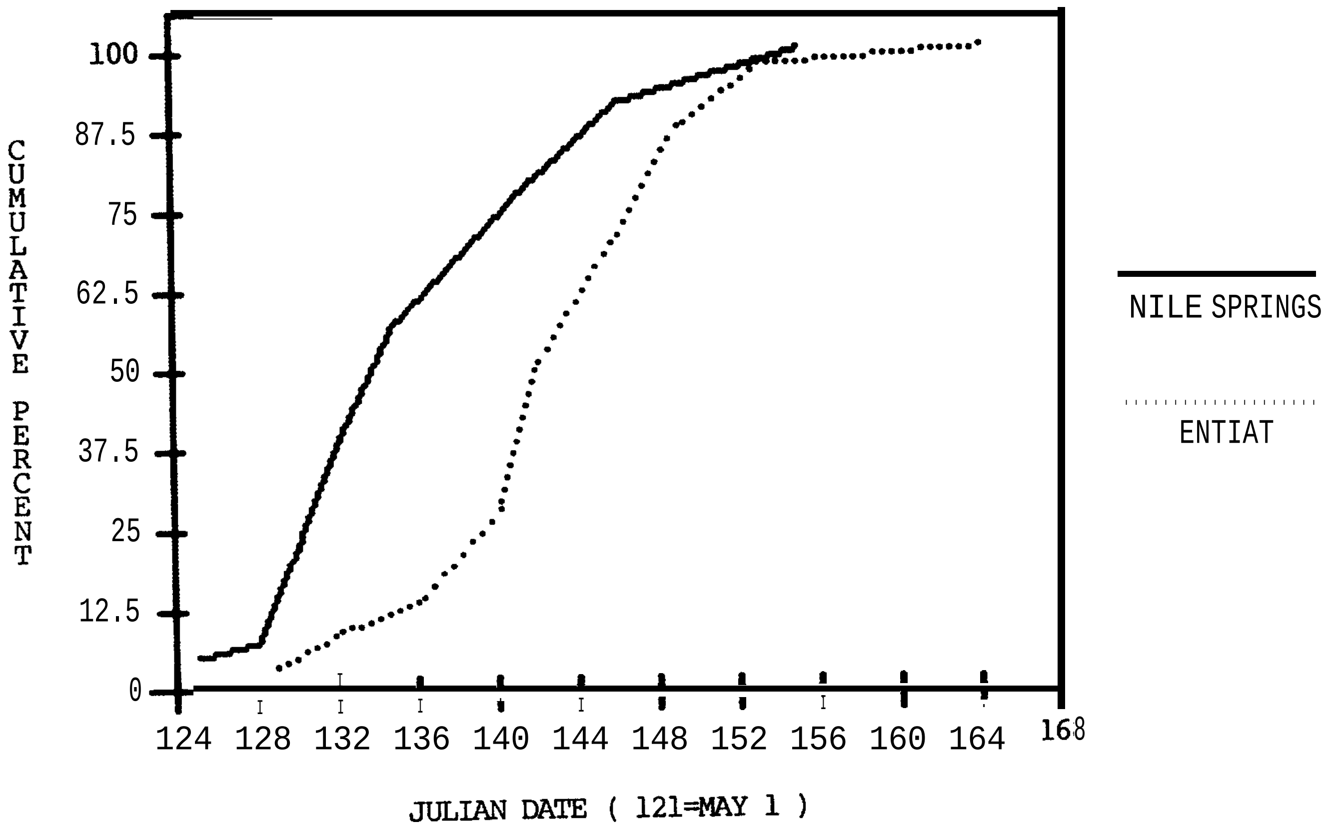


FIGURE 11. RUN TIMING OF HATCHERY SPRING CHINOOK SMOLTS TO MCNARY DAM, 1984

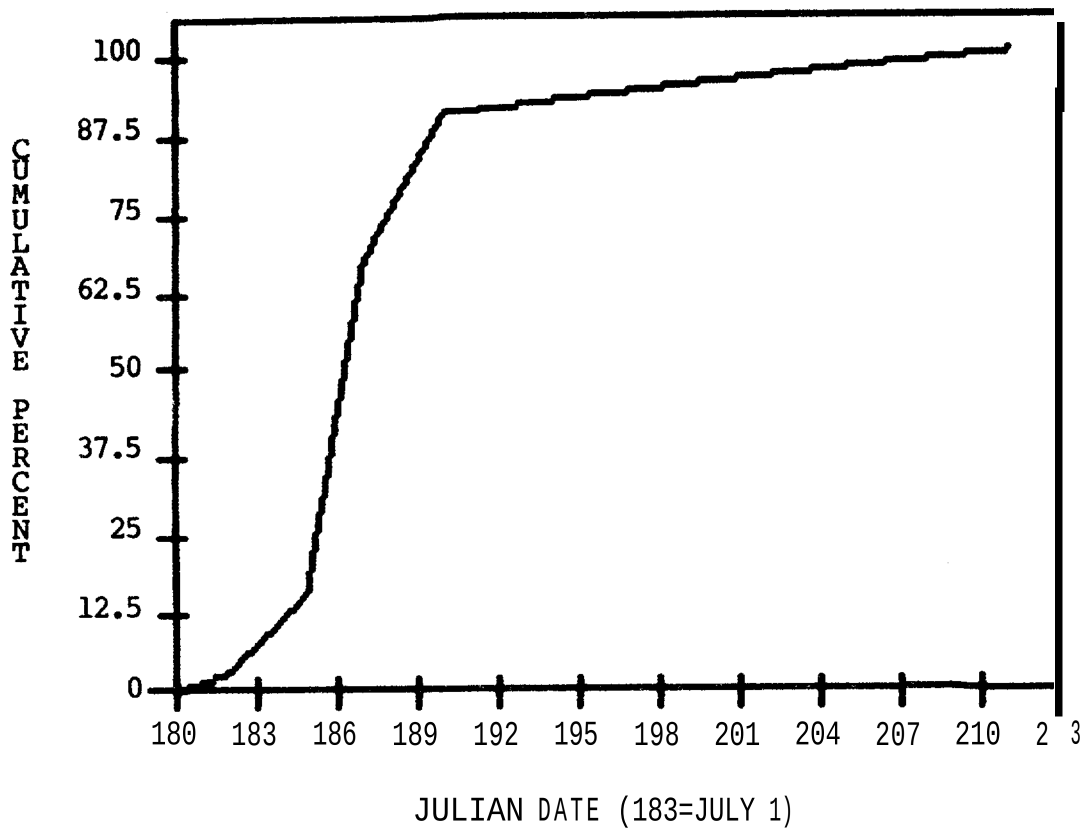


FIGURE 12. RUN TIMING OF HATCHERY SPRING CHINOOK FINGERLINGS AT PROSSER 1984

TABLE 15. ESTIMATED NUMBER OF STEELHEAD, FALL CHINOOK, AND COHO SMOLTS PASSING PROSSER, 1984

JULIAN DATE	WILD STEELHEAD	HATCHERY STEELHEAD	COHO	WILD FALL CHINOOK	HATCHERY FALL CHINOOK
(61-67) 3/1-3/7	24 (11-55)				
(68-74) 3/8-3/14	67 (41-107)				
(75-81) 3/15-3/21	286 (181-449)				
(82-91) 3/22-3/31	4800 (2457-9392)				
(92-98) 4/1-4/7	5230 (3228-8526)				
(99-105) 4/8-4/14	4326 (3107-6030)				
(106-112) 4/15-4/21	13266 (9637-182157)	2163 (1576-2973)			
(113-121) 4/22-4/30	15001 (10729-20983)	7566 (5433-10537)			
(122-128) 5/1-5/7	11903 (8729-18453)	2526 (1846-3912)	14 (11-22)		
(129-135) 5/8-5/14	7576 (6291-12368)	1245 (1016-2017)	66 (56-108)	1222 (1021-1997)	
(136-142) 5/15-5/21	10792 (7188-16282)	1617 (1120-2342)	144 (93-221)	6638 (4364-10153)	
(143-152) 5/22-5/31	9576 (5250-17494)	309 (170-566)	290 (156-539)	19104 (10575-34575)	
(153-159) 6/1-6/7	3427 (1946-6017)	287 (165-500)	92 (50-165)	9373 (5337-16424)	
(160-166) 6/8-6/14	426 (216-838)	- - -	- - -	7871 (3973-15620)	
(167-173) 6/15-6/21	337 (167-675)	32 (17-14)	17 (9-34)	3338 (1667-6676)	24 (10-52)
(174-182) 6/22-6/30	- - -	- - -	- - -	1624 (647-4045)	2485 (930-6606)
(183-189) 7/1-7/7	232 (113-476)			2043 (971-4393)	58468 (30797-113399)
(190-196) 7/8-7/14	6 (6-6)			688 (537-920)	8180 (6679-11369)
(197-203) 7/15-7/21	2 (2-2)			202 (202-202)	2447 (2413-2447)
(204-213) 7/22-7/31	- - -			106 (106-106)	582 (578-582)
T O T A L	87277 (59299-136410)	15745 (11340-22916)	623 (375-1089)	52189 (29400-95111)	72186 (41397-134455)

*Numbers in parenthesis are 90% confidence limits

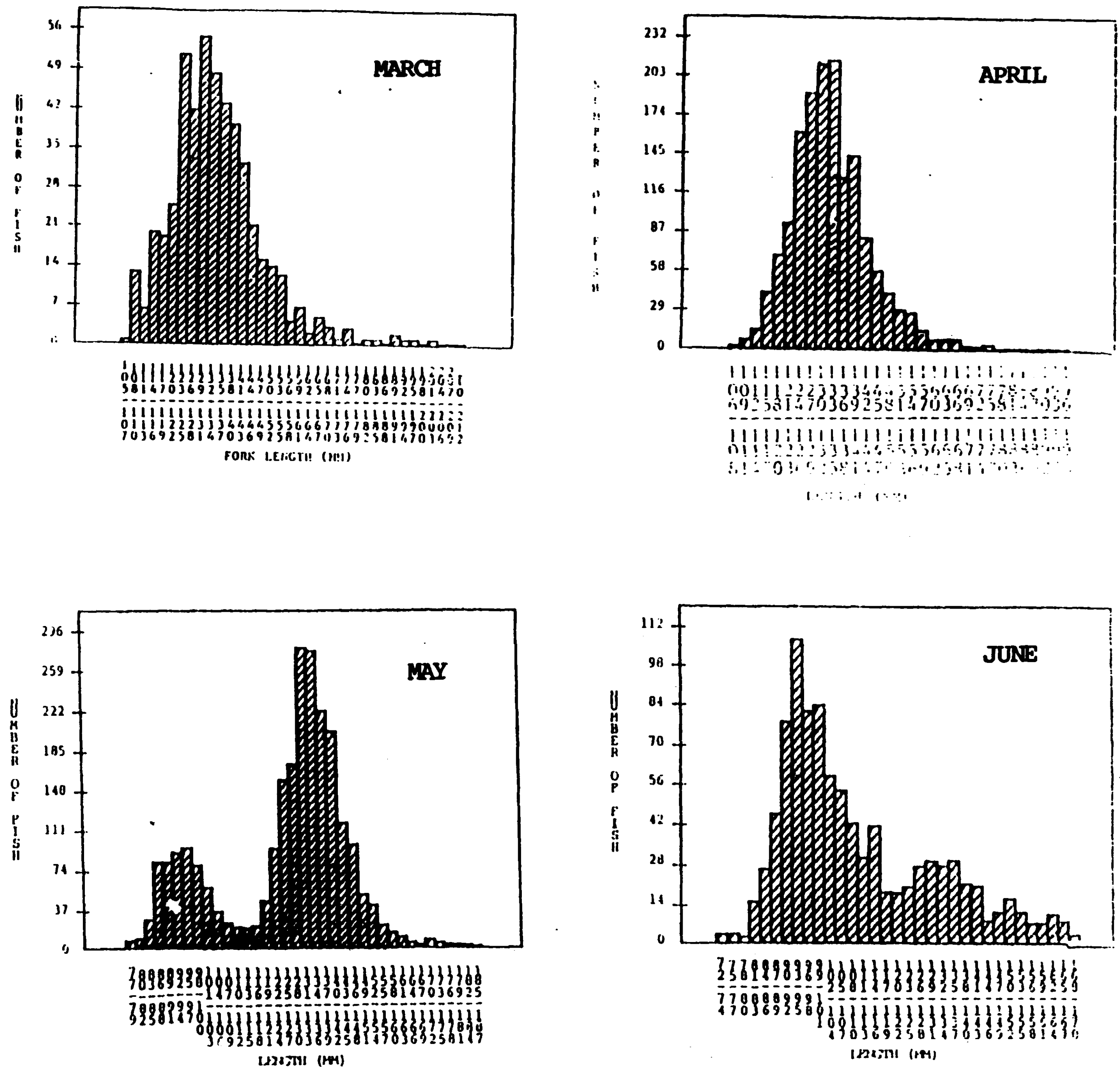


FIGURE 13. LENGTH FREQUENCY HISTOGRAM OF CHINOOK SMOLTS AT PROSSER, 1984

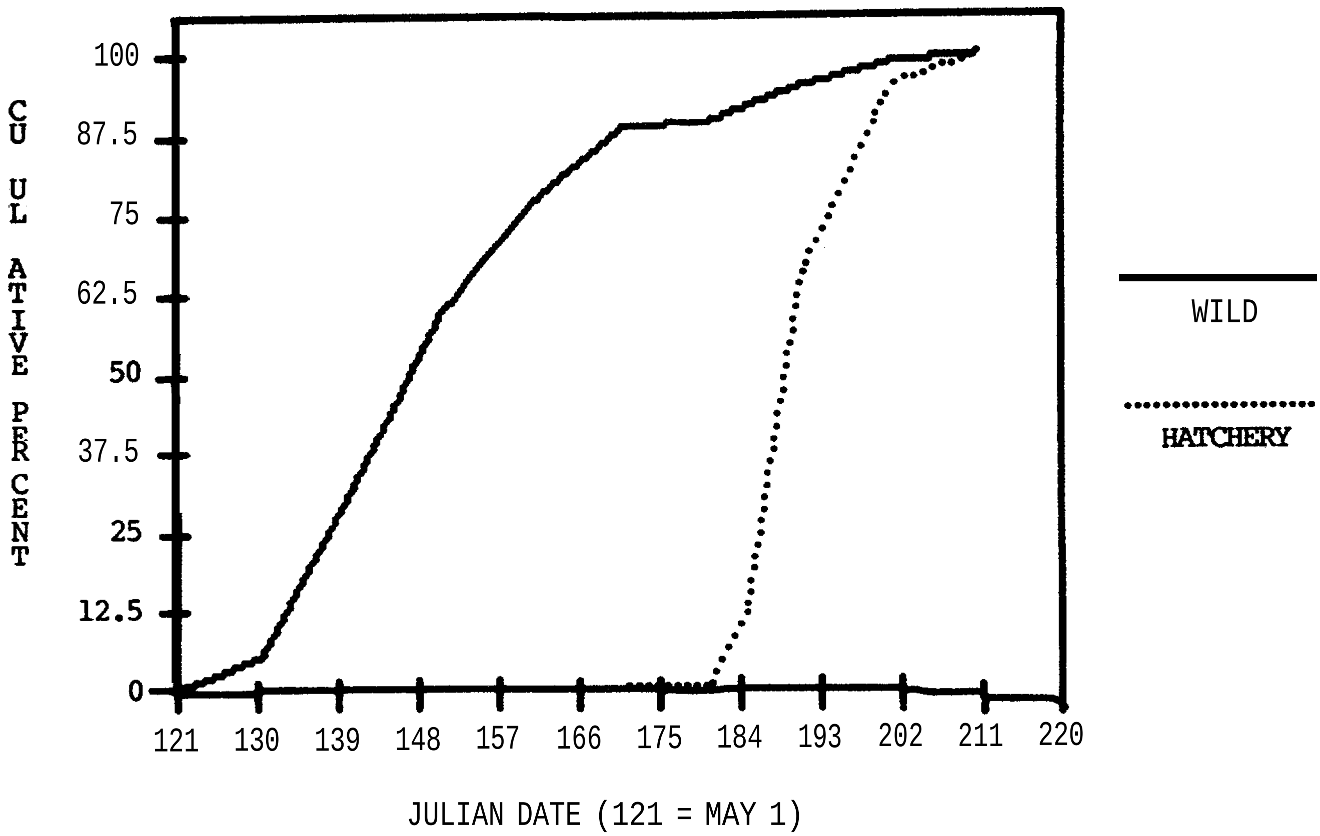


FIGURE 14. RUN TIMING OF WILD AND HATCHERY FALL CHINOOK SMOLTS AT PROSSER 1984

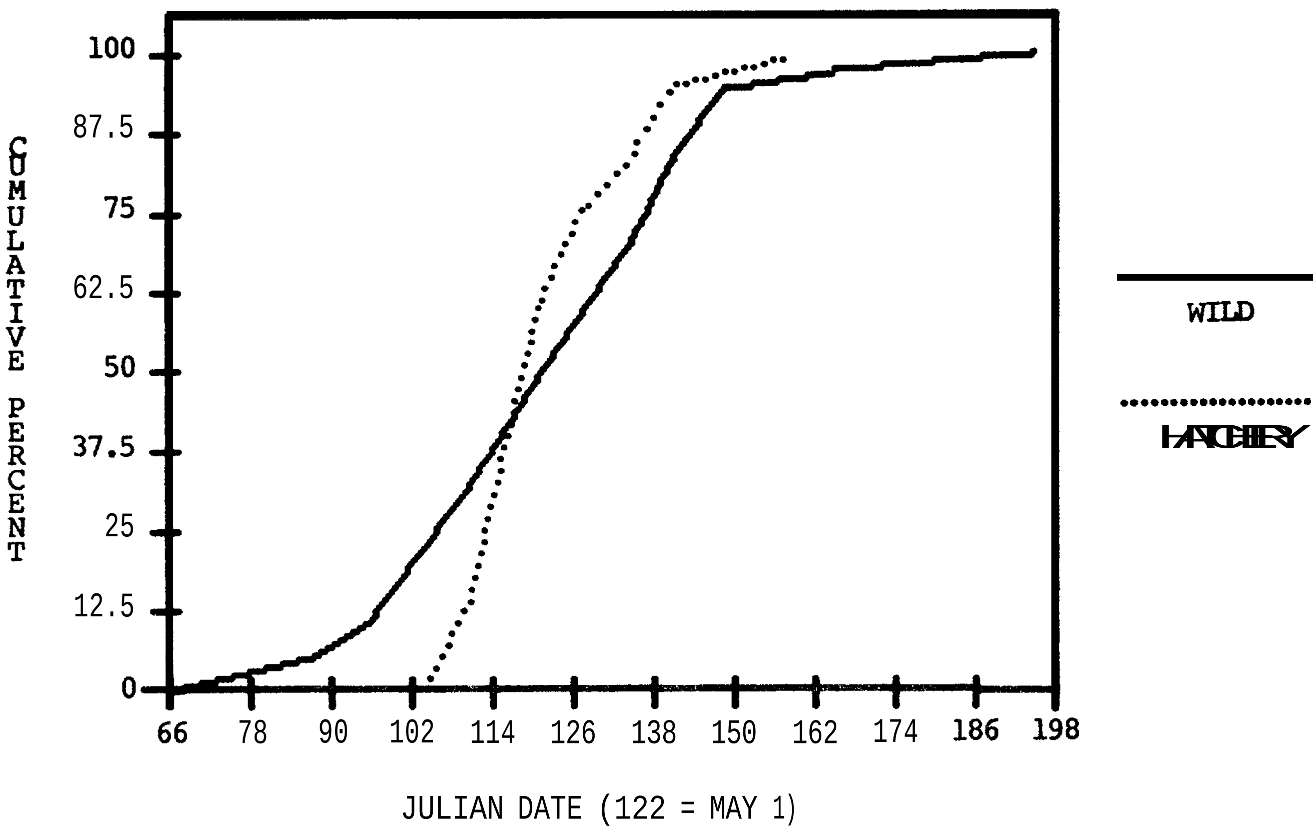


FIGURE 15. RUN TIMING OF STEELHEADSMOLTS AT PROSSER 1984

close trucked from Entiat Hatchery was 66.4% and 42.8% respectively. In 1983, there was no measure of trapping efficiency related to flows. Based on the flow efficiency model developed in 1984, estimates for passage for smolts at Prosser for 1983 was calculated. Data is presented in Table 16. It was estimated that 213,018 wild spring chinook passed Prosser in 1983. There were 8,192 and 9,905 branded fish trucked from Leavenworth Hatchery released directly into the Yakima River and Nile Springs, respectively. Estimates for 1983 show that 3,004 and 6,181 branded spring chinook smolts migrated past Prosser from the transported and Nile Spring Groups. There was a total of 139,227 hatchery spring chinook that migrated past Prosser in 1983. Run timing of all groups is presented in Figure 16. The median date of passage of wild spring chinook was April 23 while for transported fish, and those from Nile Springs, the median dates were May 4th and 7th and respectively. The Yakima Chapter of the Northwest Steelheaders released 64,810 steelhead from Nelson Springs in 1983. These fish resulted in an estimated migration past Prosser of 19,633 (30%). Run timing is illustrated in Figure 17.

Survival rates for various groups of fish released in 1984 is presented in Table 17. The survival of fish released from Nile Springs was 1.6 times greater than the transported group. In 1983, survival from Nile Springs was 62.4% and for those transported 36.7%. Therefore, the fish from Nile Springs had a survival rate that was 1.7 times that of the transported fish. Based on these two years of data the relative survival of fish released from Nile Springs is considerably higher than that calculated for fish transported from the hatchery for release into the Yakima River.

As part of ongoing studies to determine optimum release timing for spring chinook, approximately 104,000 fingerlings were released into the Upper Yakima River in early June, where it was expected they would rear until the following spring when they would leave as smolts. In fact, 32.6% of these fish were estimated to have passed Prosser in June and July Therefore, a large percentage of these fish left the Yakima Basin as zero age fish, which is contrary to that observed for wild Yakima River Spring Chinook. Although the fate of these fish is unknown, the possibility exists that they could

Table 16. **Estimated Passage Of Smolts Past Prosser, 1983**

GROUP	POINT [redacted]	UPPER BOUND + 90% C.I.	LOWER BOUND - 90% C.I.
wild Spring Chinook	213,018	405,048	113,953
Hatchery Spring Chinook	139,227	281,232	69,471
Nile Springs	6,181	12,777	2,994
Transportaed	3,004	5,954	1,529
wild Steelhead	91,750	177,187	48,300
Hatchery Steelhead	19,633	38,553	10,125
wild Fall Chinook	154,277	303,222	81,619

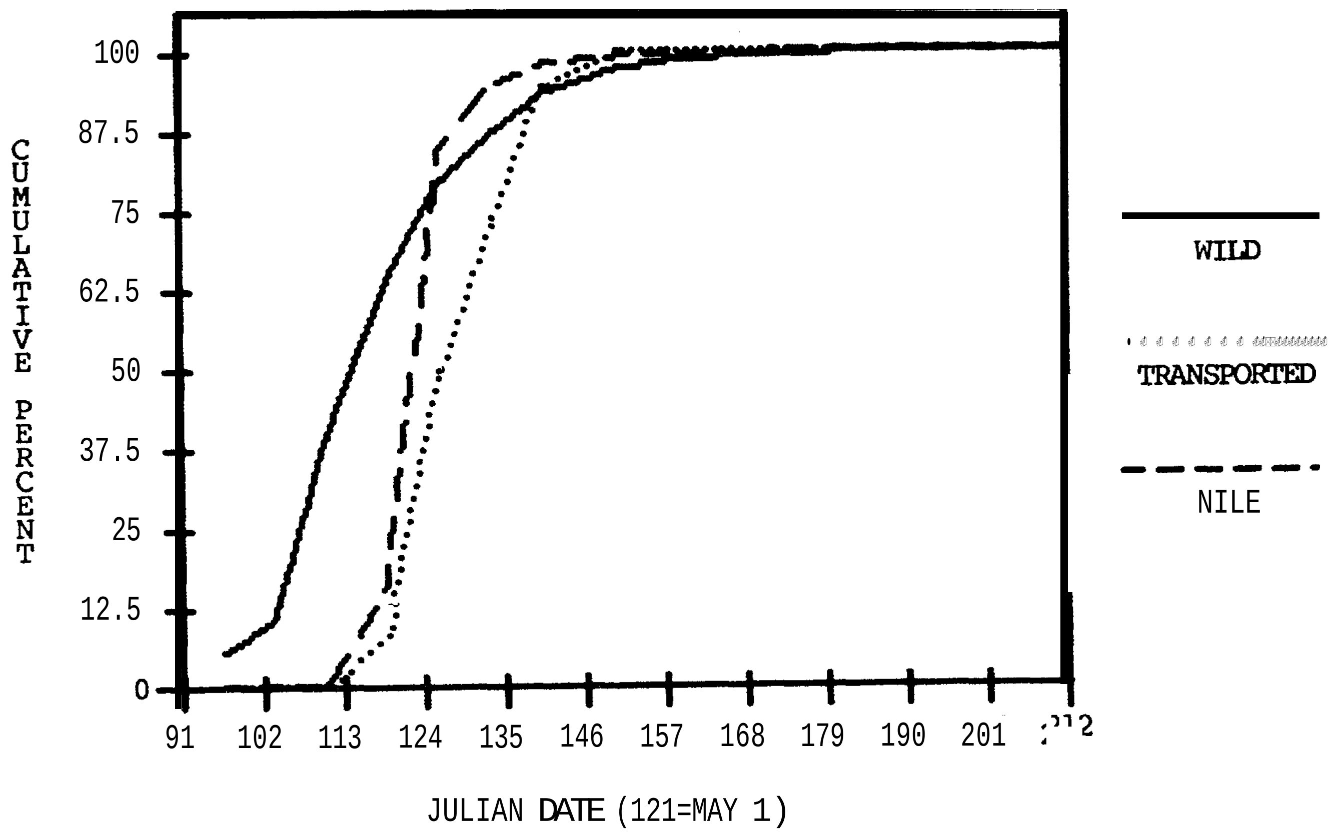


FIGURE 16. RUN TIMING OF SPRING CHINOOK SMOLTS PAST PROSSER IN 1983

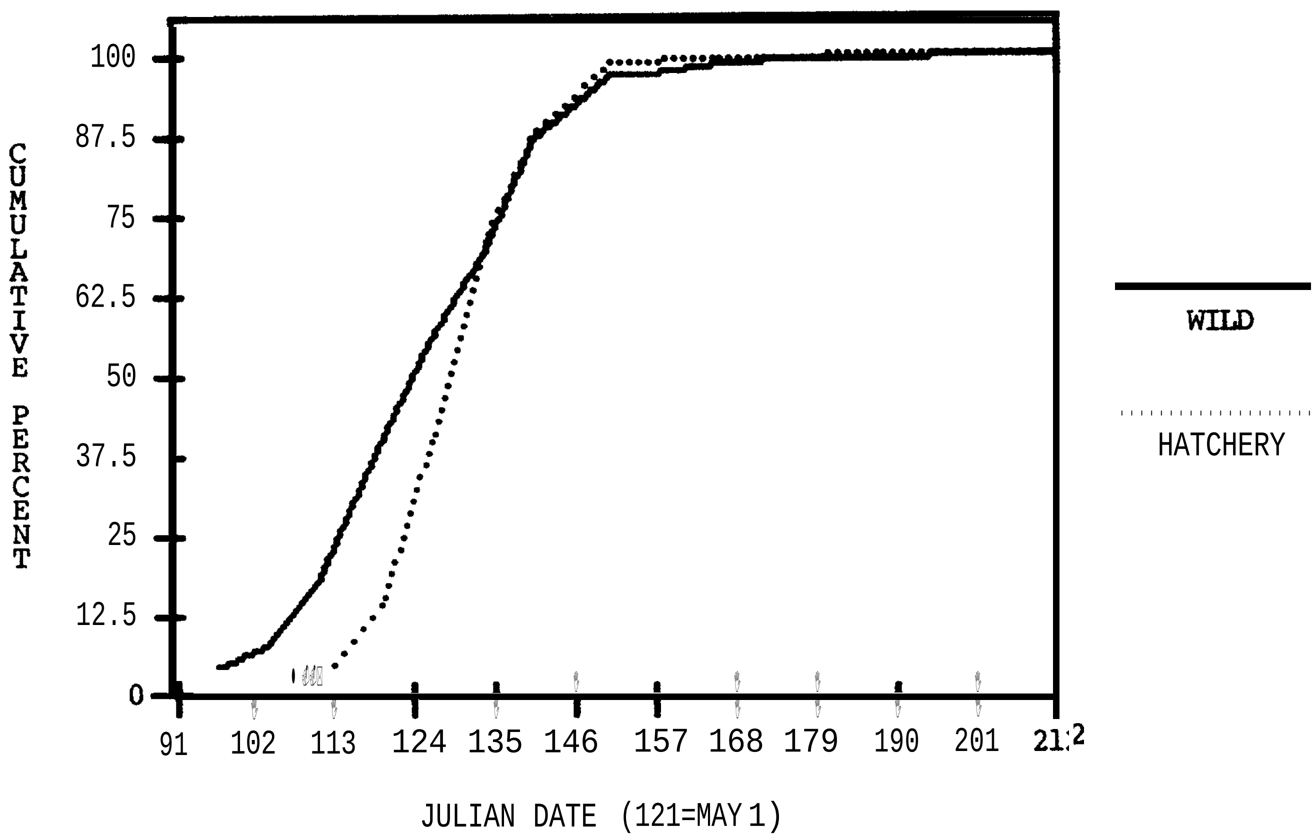


FIGURE 17. RUN TIMMING OF STEELHEAD SMOLTS PAST PROSSER IN 1983

Table 17. Survival Rates of Salmonids Released into the Yakima River, 1984.

SPECIES	RELEASE LOCATION	NUMBER RELEASED	NUMBER CAPTURED	% SURVIVAL
Spring Chinook	Nile Springs	4,653*	3,088	66.4%
Spring Chinook	Upper Yakima	6,818*	2,916	42.8%
Spring Chinook	Upper Yakima**	93,067	30,343	32.6%
Steelhead	Nelson Springs	49,288	15,745	31.9%
Fall Chinook	Sunnyside Dam	103,722	72,186	69.6%

* Numbers are based on branded fish released.

** This release is for fingerlings released in June, and survival is actually the number of fish moving dowstream to Prosser. Other fish may have remained upstream near release sites.

successfully rear in the Columbia River until the following spring, at which time they would exit as smolts. The evaluation of this release timing Will ultimately be based on adult return rates in 1987 and 1988.

Adults Returns

A summary of adult returns is presented in Table 18. In 1984 2,340 adult and 218 jack spring chinook were counted at Prosser Fish ladder, (RM 48) yielding a total of 2,558 fish (Table 19). In addition, it was estimated that 119 fish were caught below Prosser and Horn Rapids Dams in tribal dipnet fisheries (Yakima Indian Nation Fisheries Resource Management Information Report 84-2). Therefore, total return to the river was 2,677 fish. This was the largest run of spring chinook to the Yakima River in 26 years. At Roza Dam, 1,334 adults and 245 jack salmon were counted, for a total of 1,579 fish (Table 20). From this total 84 fish were taken for brood stock purposes, leaving 1,495 fish available to spawn in the Upper Yakima River. It was calculated 809 fish were available to spawn in the Naches River based on the number of fish counted at Prosser (2,558) minus the harvest above Prosser (170) minus the number counted at Roza ladder (1579). Appendix Tables B.20-B.21 present daily summaries for adult spring chinook at Prosser and Roza Fish ladders.

The median date of arrival of spring chinook at Prosser Dam was May 22nd (Figure 18). Six fish were captured on May 2nd, the first complete day of sampling and the last adult spring chinook was counted at Prosser on July 21st. At Roza Dam, the median date for wild fish was June 13th (Figure 19). Median date for hatchery fishway June 1st. Since only 11.3% of the hatchery fish returning were tagged, the untagged component tends to shift the curve to an earlier date. However, the percentage of the run to Roza Dam comprised of unmarked hatchery fish is 13.4% (212/1,579), so the shift is only minor.

Age class composition of spring chinook returning to the upper Yakima River can be derived from Figure 20. There are three nodes observed, 381-455 mm, 456-755 mm, and 781-805 mm. These nodes most likely correspond to jack, 4 year old, and 5 year old adults. This is based on mid-eye to hypural plate length measurements taken from 176 carcasses. Based on this analysis, jacks,

Table 18. Adult Spring Chinook Returns To The Yakima River, 1984

Adults to Prosser Dam	2,340
Jacks to Prosser Dam	218
Total Run to Prosser	2,558
Harvest	119
Total run to the River	2,677
Adults to Roza Dam	1,334
Jacks to Roza Dam	245
Total Run to Roza	1,579
Number removed from Roza for brood stock evaluations	84
Total number available to Spawn in the Upper Yakima River	1,495
Harvest above Prosser	170
Total Harvest	289
*Number of Fish available to Spawn in the Peaches River	809

*Calculated as Number of Fish counted at Prosser ladder-harvest above Prosser-Number counted at Roza ladder.

Table 19. Weekly Passage Of Adult Spring Chinook To Prosser, 1984

(1) Weekly chinook total passage; (2) Weekly proprotion of chinook total passage; (3) Cumulative chinook total passage, (4) Cumulative proportion of chinook total passage.

WEEK	DATE	(1)	(2)	(3)	(4)
1	507	a6	0.0336	86	0.0336
2	514	403	0.1576	489	0.1912
3	521	a43	0.3297	1332	0.5209
4	528	399	0.1560	1731	0.6770
5	GO4	392	0.1533	2123	0.8303
6	611	175	0.0684	229a	0.8987
7	618	132	0.0516	2430	0.9503
a	625	62	0.0242	2492	0.9746
9	702	33	0.0129	2525	0.9875
10	709	20	0.0078	2545	0.9953
11	716	12	0.0043	2557	0.9996
12	723	1	0.0004	2558	1.0000

&an Da te : 3.94095 Variance: 3.37899
Skewness: 1.08273 Ku rtosis : 1.27974

Table 20. Weekly Passage Of Adult Spring Chinook To Roza Dam, 1984

(1) Weekly chinook adult passage; (2) Weekly proportion of chinook adult passage; (3) Cumulative chinook adult passage; (4) Cumulative proportion of chinook adult passage.

WEEK	DATE	(1)	(2)	(3)	(4)
2	514	2	0.0015	2	0.0015
3	521	6	0.0045	8	0.0060
4	528	58	0.0434	66	0.0494
5	604	325	0.2431	391	0.2924
6	611	166	0.1242	557	0.4166
7	618	283	0.2117	840	0.6283
8	625	103	0.0770	943	0.7053
9	702	126	0.0942	1069	0.7996
10	709	196	0.1466	1265	0.9461
11	716	19	0.0142	1284	0.9604
12	723	4	0.0030	1288	0.9634
13	730	7	0.0052	1295	0.9686
14	806	8	0.0060	1303	0.9746
15	813	12	0.0090	1315	0.9835
16	820	1	0.0007	1316	0.9843
17	827	11	0.0082	1327	0.9925
18	903	5	0.0037	1332	0.9963
19	906	2	0.0015	1334	1.0000

Mean Date: 7.33134 Variance: 5.98312
Skewness: 1.22432 Kurtosis: 2.60742

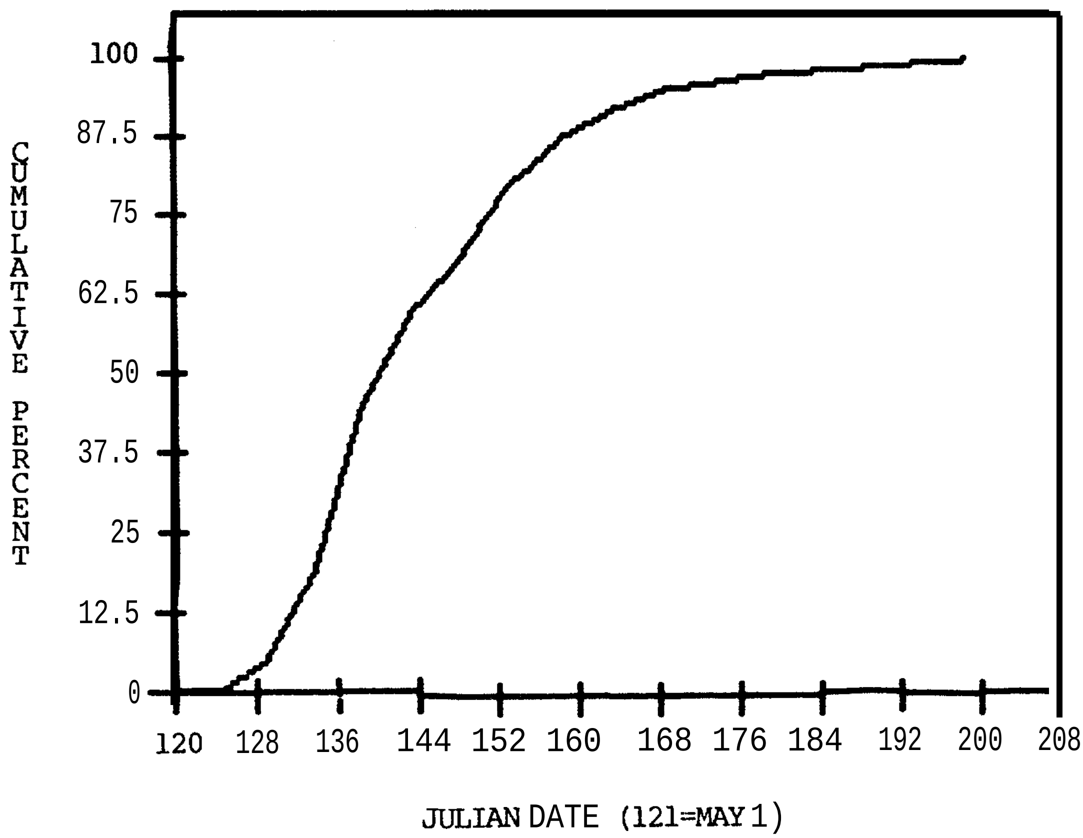


FIGURE 18. RUN TIMING OF ADULT SPRING CHINOOK AT PROSSER DAM 1984

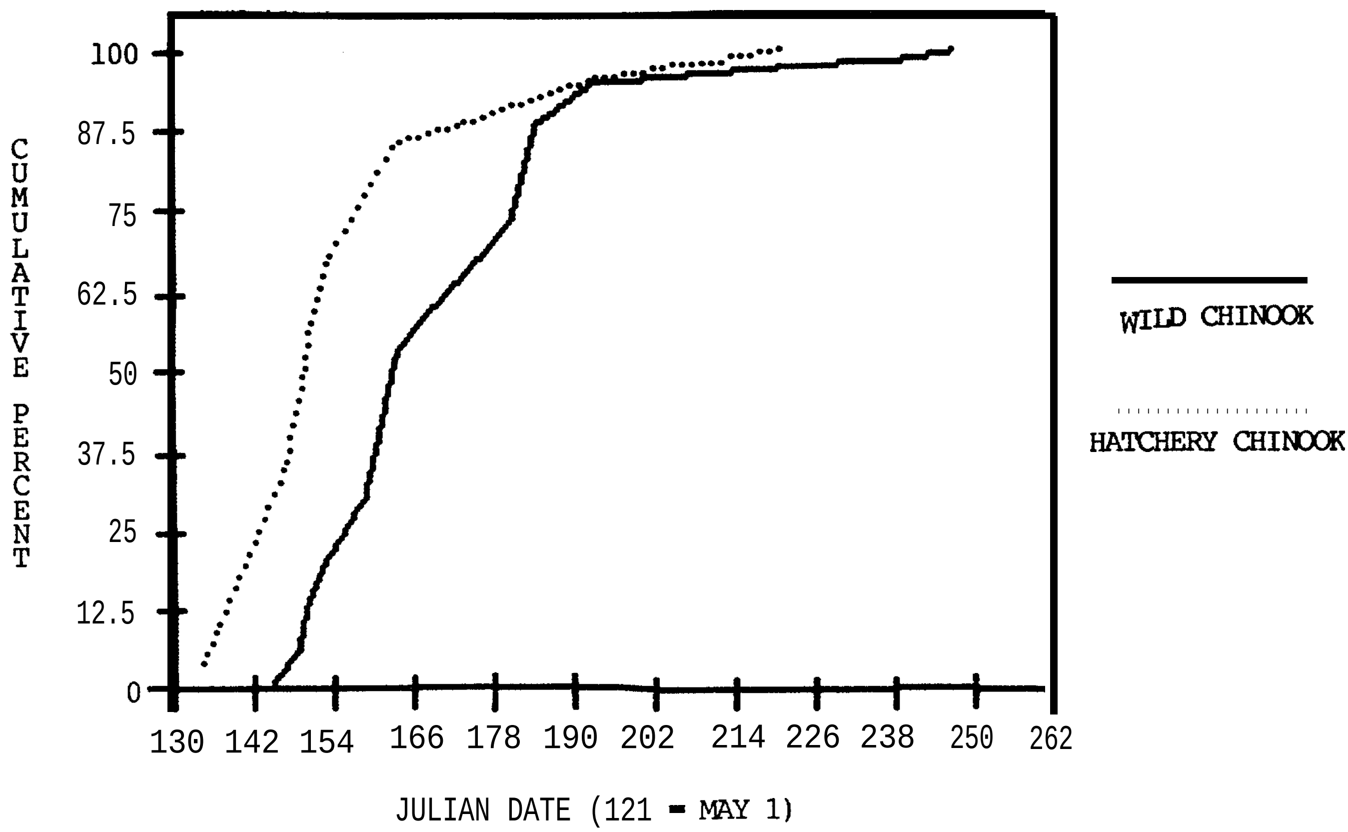


FIGURE 19. RUN TIMING OF ADULT SPRING CHINOOK AT ROZA DAM 1984

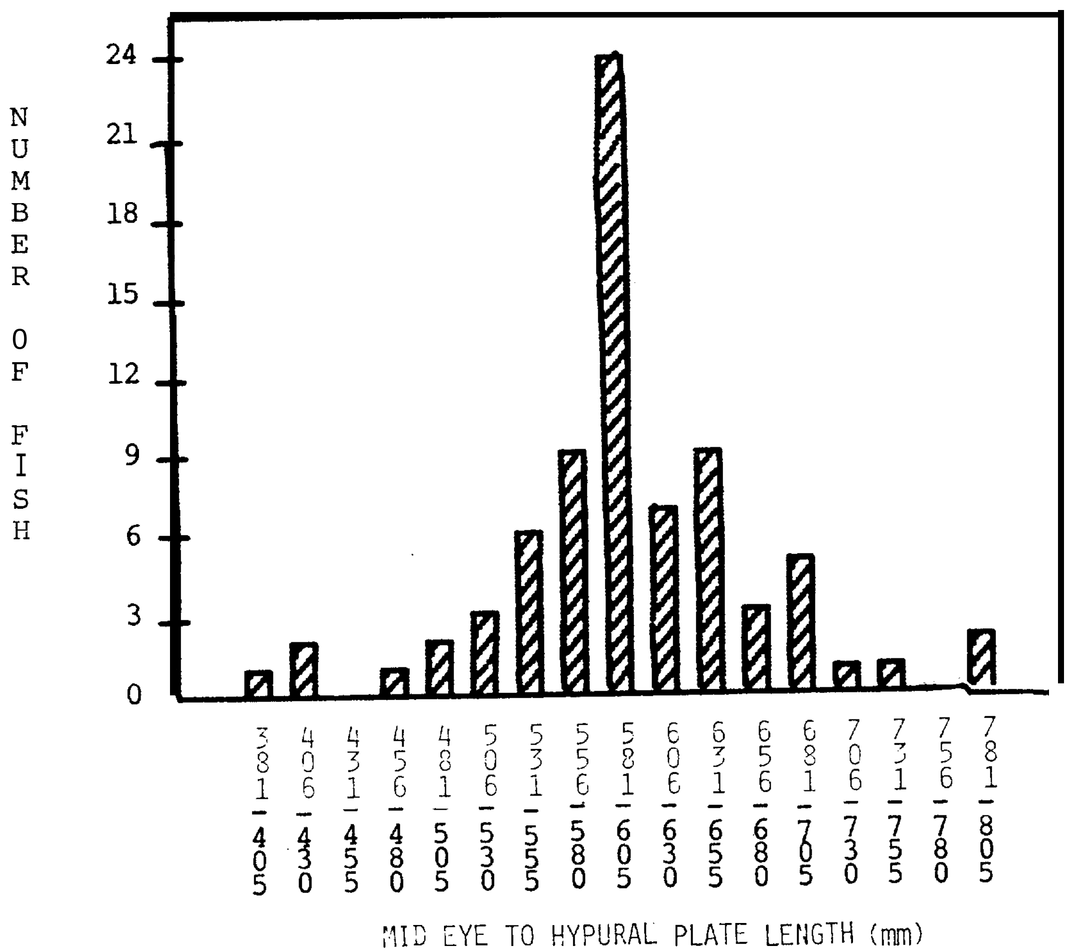


FIGURE 20. LENGTH-FREQUENCY DISTRIBUTION OF YAKIMA RIVER SPAWNERS 1984

4 year old and 5 year olds comprise 4 %, 93.4%, and 2.6% respectively. There were an insufficient number of carcasses recovered in the Naches System to do a similar analysis.

Hatchery Returns

In 1982, 401,714 1980 brood spring chinook smolts were released into the upper Yakima River from Leavenworth N.F.H. Of this group, 45,394 (11.3%) fish were given coded wire tags, and had adipose fins removed. In the Naches River, 100,050 spring chinook were released from Nile Springs, of which 21,814 (21.8%) were adipose clipped and coded wire tagged.

In 1984, marked fish were recovered or observed in 3 places; (1) the tribal dipnet fishery (2) at Roza Dam. (fish passing over the counting board were visually examined for the presence or absence of an adipose fin) (3) from carcass recoveries on the spawning grounds.

A total of 205 fish were examined from the tribal fishery, of which one was missing an adipose fin. Subsequent tag analysis showed that his fish was previously released from Nile Springs.

There were 1,334 adult spring chinook observed at Roza Dam, of which 29 were missing adipose fins.(Table 21). In addition, 2 marked fish were initially taken as part of the brood stock evaluation yielding a total of 31 fish. Based on a mark rate of 11.3% this yields an estimated passage of 274 hatchery fish or 20.5% of the total number counted at Roza. Thus, from a release of 401,714, the return of four year old fish was .068%. The overall return rate will be calculated in 1985 when returning five year olds are examined. Figure 19 illustrates the run timing of these fish past Roza Dam.

The timing of hatchery fish was considerably earlier than that observed for the wild population. The median arrival date to Roza Dam was June 1st and June 13th for hatchery and wild fish respectively. This may indicate that spawning will occur earlier for the hatchery fish. Aerial spawning ground surveys on the Yakima River surveys revealed the presence of 8 redds before September 1st. There has been no previous documentation of fish spawning before September in this part of the Upper Yakima River. Early spawning hatchery fish have severe implications with regard to water flow management in

Table 21. Weekly Passage Of Adipose Clipped Adult Spring Chinook To Roza Dam, 1984

(1) Weekly adipose clipped adult chinook passage; (2) Weekly proportion of adipose clipped adult chinook passage; (3) Cumulative adipose clipped adult chinook passage; (4) Cumulative proportion of adipose clipped adult chinook passage.

WEEK	DATE	(1)	(2)	(3)	(4)
2	514	1	0.0357	1	0.0357
3	521	2	0.0714	3	0.1071
4	528	7	0.2500	10	0.3571
5	604	9	0.3214	19	0.6786
6	611	1	0.0357	20	0.7143
7	618	4	0.1429	24	0.8571
8	625	1	0.0357	25	0.8929
9	702	0	0.0000	25	0.8929
10	709	1	0.0357	26	0.9286
11	716	1	0.0357	27	0.9643
12	723	0	0.0000	27	0.9643
13	730	0	0.0000	27	0.9643
14	806	0	0.0000	27	0.9643
15	813	0	0.0000	27	0.9643
16	820	0	0.0000	27	0.9643
17	827	1	0.0357	28	1.0000

Mean Date: 5.75 Variance: 8.54464
Skewness: 2.18611 Kurtosis: 5.57016

the Yakima River. A 1980 Federal Court decision declared that flows must be provided to insure the survival of redds in the Upper Yakima River. The management scheme designed to fulfill this obligation is to lower flows in the Upper Yakima River during the first week of September (at the historical onset of spawning) so that fish will not spawn near the banks. Therefore additional flaws would not be required to keep redds wet following the irrigation season. Irrigation demands downstream are met by releasing additional water from reservoirs in the Naches River. This procedure has been termed "flip-flop" since irrigation flows are flip flopped from the Yakima to the Naches storage. With present storage capabilities in the basin, flip flop cannot take place earlier than September 1st. Supplementation of spring chinook runs with an earlier spawning stock would run the risk of inadequate flows during the incubation period. There is also the possiblity that fry from an early spawning stock will emerge too soon in the spring, when water temperatures and abundance of food are low, and flows are high. Chilcote et al. (1983) have postulated this to be the case for steelhead on the Kalama River. In their investigation, the lower reproductive success of hatchery steelhead was believed to be the result of inappropriate emergence timing. More extensive surveys will take place beginning in 1985 to better identify the source of these earlier spawning fish, and to determine what component spawns before September 1st.

Table 22 presents data from carcasses recovered during spawning ground surveys conducted in 1984. A total of 62 carcasses were recovered from the Naches River of which 4 were missing adipose fins. Based on a mark rate of 26.6%, 15 of the 62 carcasses that were recovered, or 24% were of hatchery origin. Smolts were released in 1982 from Nile Springs, and of the 4 tagged adults recovered only one was captured in the Naches River. There was one carcass recovered from Rattlesnake Creek, the first major tributary downstream from Nile Springs. Two carcasses were found in the Little Naches River, located 15.8 miles upstream from the mouth of Nile Springs Creek. Based on a estimated adult return to the Naches River of 809 fish, and a hatchery componenent of 24%, there were 194 adults of hatchery origin returning to the Naches River. this is equivalent to a return rate of .19% for four year old spring chinook released.

Wale 22. Carcass Recoveries from Spawning Ground Surveys, Screen Evaluations and Brood Stock Collection, 1984

Location	Adipose Present			Adipose Absent			
	Male	Female	Sex unknown	Jack	Male	Female	Sex Unknown
Naches System							
Naches River	8	7				1	
Rattlesnake Cr.	2					1	
American River	10	10					
Little Naches R.	6	12				2	
Bumping River	1	2					
Total	27	31				4	
Yakima River							
Spawning Grounds	35	113				6	
Brood Stock			84				2
Screen Evaluations			31				
TOTAL	89	175	115	2		14	2

On the Yakima River 240 carcasses were checked on the spawning grounds and from fish taken for brood stock evaluations. From this group, eight adults, and two jacks had been coded-wire tagged. Based on a marking rate of 11.3%, the eight adults were expanded to 71 adults. The ratio of hatchery to wild fish on the spawning grounds was 7l/240 or 29%.

There were 31 carcasses recovered at Sunnyside Fish Screens and below the east branch of Wapato Dam. One of the fish recovered was radio tagged as an adult by the Army Corps of Engineers on April 25th at the Bonneville Dam tailrace, (Donald Bryson A.C.E., personal communication).

Based on 809 fish returning to the Naches River and 1,579 for the Yakima River, 33.8% of the fish returning to the Yakima System were bound for the Naches System. The total number of fish examined for coded-wire tags were:

205 from the fishery
62 from Naches River spawning ground surveys
86 from Lost Creek brood stock analysis
156 from Yakima River spawning ground surveys
31 from screen evaluations

This yields a total of 540 fish sampled, or 20.2% of the total run. There were 4 tags from the Naches System and a mark rate of 26.6%, and 8 tags recoveries from the Yakima River with a marking rate of 11.3%. Based on 33.8% of the run returning to the Naches System, this results in a total hatchery run of 470 fish. With a total run of 2667, this indicates that 18% of the returning adults were four year olds of hatchery origin resulting from the 1982 smolt releases.

Screen Evaluations

Roza Canal

During adult counting operations at Roza Dam, many dead juvenile spring chinook were observed at Roza Canal fish screens. During the course of this investigation, fish were counted for 2 hours each day, and a total of 1,889 fish were recovered. The majority of fish killed were of hatchery origin

TABLE 23 FINGERLINGS KILLED ON ROZA SCREENS, 1984

DATE	WILD	HATCHERY
06/18	1	3
06/19	1	
06/25	1	3
06/26	1	2
06/28	1	58
06/29	3	39
07/01	8	113
07/02	8	251
07/03	8	89
07/04	5	138
07/05	1	93
07/06	5	144
07/07	2	5Ø
07/08	1	23
07/09	4	33
07/10	Ø	184
07/11	1	94
07/12	0	92
07/13	2	142
07/14	1	20
07/15	0	1
07/16	2	2
07/17	1	3
07/18	1	18
07/19	3	53
07/20	8	5Ø
07/21	4	32
07/22	4	19
07/23	6	5
07/24	4	Ø
07/25	2	1
07/26	Ø	7
07/27	5	1
07/28	2	5
07/29	1	1
07/30	4	5
07/31	4	5
08/01	2	1
08/02	Ø	1
08/04	Ø	2
08/05	1	2
08/06	1	Ø
08/07	4	1
08/09	Ø	0
08/11	Ø	0
08/13	Ø	0
08/14	Ø	0
TOTAL	113	1,745

(Table 23) resulting from a release of 100,000 fingerlings on June 5-6 released at RM 152-201. From this data it is clear that a large number of fish moving down the river were killed at this installation. Timing of these losses is presented in Figure 21. There was a similar, smaller downstream movement of wild spring chinook that took place atthistime. Themediandate of recovery of the wild fish was approximately July 15th, while half the hatchery fish were captured by July 8th, nearly one month after release. These hatchery fish were released as part of an investigation of optimum release timing, with the intention that they would rear in the upper watershed and migrate from the watershed as smolts. Based on the large number of fish captured at the screens, it appears that these fish may not contribute to adult returns. This will be further evaluated in 1986 and 1987.

When Roza Canal was dewatered in late October, electroshocking surveys were undertaken to document the incidence of fish stranded in the canal. Data is presented in Table 24. Two hundred eighty six trout and 124 chinook were captured in the open canal one mile below the first siphon. There were generally more fish captured in tunnels or overpasses where bird predation would be minimized, Siphons were large protected areas that could not be sampled due to the channel configuration, but these areas most likely provided refuge areas for fish. All tunnels in Roza Canal were sampled except the one closest to the Roza Dam, which was inaccessable. It was estimated that a total of 308 fish resided in the tunnels. This is a minimum value since some predation took place before sampling, and the tunnel at canal mile 11.0 was drained before it could be sampled.

Sunnyside Canal

As part of a preliminary analysis conce .ed with the benefits of replacing Sunnyside fish screens, an individual sampled fish at the screens 3 days per week from 8:00 p.m. to 8:00 a.m. from May 7 to August 4, 1984. Results of this analysis is found on Table 25. A total of 22 adult chinook were found dead on the screens. Some of these adults had died previously and drifted into the screens, while the remainder were in poor condition and died upon becoming impinged on the screens. The main reason for these losses was

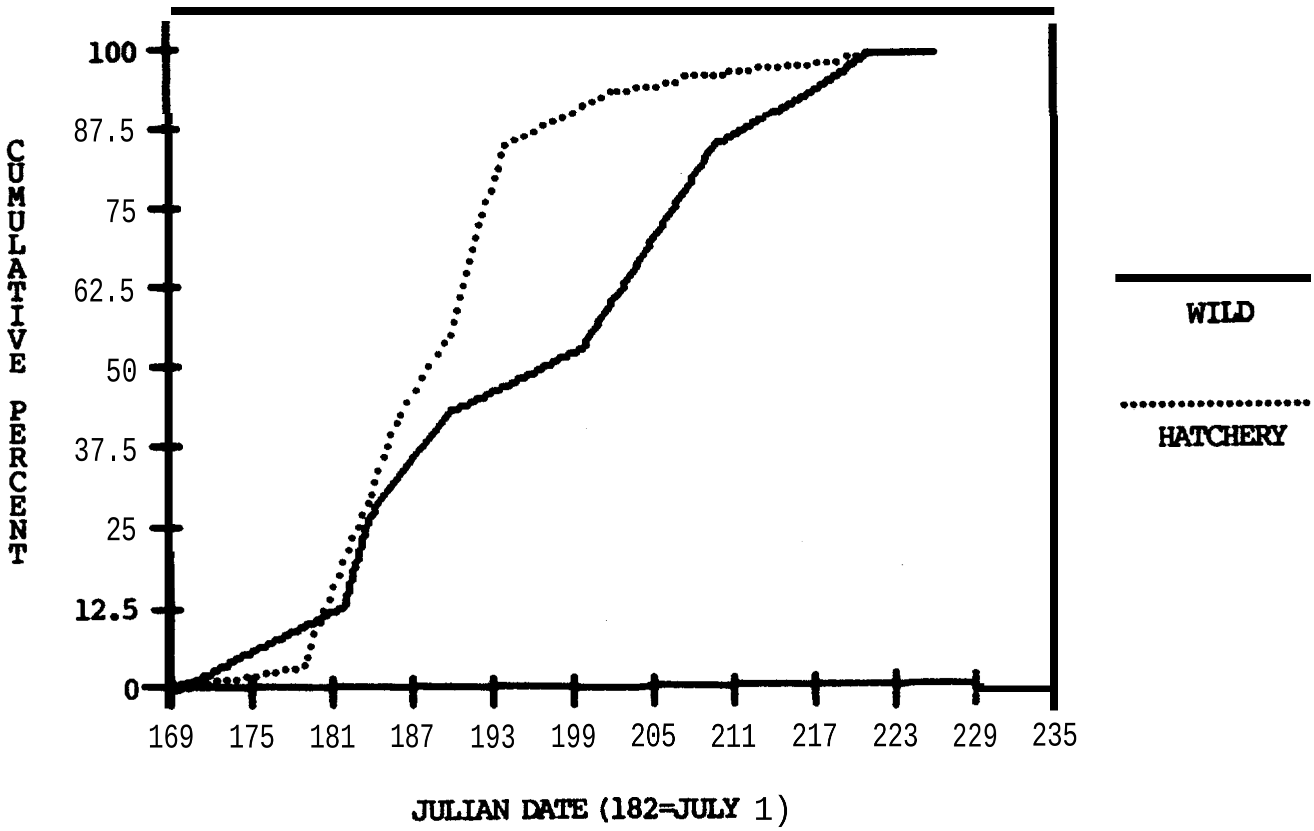


FIGURE 21. TIMING OF CAPTURES OF SPRING CHINOOK FINGERLINGS AT ROZA FISH SCREENS 1984

Table 24. Post Irrigation Season Captures of Fish in Roza Canal October 26-November 14, 1984.

LOCATION CM	CHANNEL TYPE	LENGTH SAMPLED (M)	AREA SAMPLED (M^2)	SPECIES*	POPULATION ESTIMATES (± 95% C.I.)	MEAN LENGTH (MM)
4.6	open	2,093	31,395	SpgChnk	124(112-131)	134
				Trout	286(266-306)	
7.2	open	140	2,100	Trout	2	165
8.3	open	89	837	Trout	53 (43-60)	187
11.0	Tunnel	200	917	SpgChnk	2	133
				Trout	6	125
12.5	open	128	1,037	Trout	3	146
17.6	open	155	752	SpgChnk	1	126
				Trout	23(20-27)	162
27.6	open	100	3.90		0	
28.0	Tunnel	1,000	5,000	SpgChnk	257(254-260)	146
				Coho	4 (2 - 6)	182
				Trout	44 (42-47)	170
32.0	Tunnel	176	1,333	SpgChnk	45 (44-46)	144
				Trout	5 (3 - 7)	198
35.0	Tunnel	352	2,500	SpgChnk	4 (3 - 11)	147
				Trout	1	172
35.5	open	165	1,254		0	
37.6	open	205	1,619		0	
61.6	open	352	2,288		1	165

* Trout indicates either rainbow or steelhead trout.

* CM= Canal mile starting at Roza Dam and moving downstream

Table 25. CAPTURES OF DEAD FISH ON SUNNYSIDE SCREENS

3 DAYS/WEEK 8 pm - 8 am MAY 7 - AUGUST 4, 1984

SPECIES	# OF DEAD FISH
STEELHEAD SMOLTS	10
WILD SPRING CHINOOK SMOLTS	162
HATCHERY CHINOOK SMOLTS	66
ADULT CHINOOK	22
ADULT STEELHEAD	2
OTHER	577

probably due to the unladdered right bank at Wapato Diversion Dam, located three miles upstream. After repeated attempts at jumping the dam, fish lose strength and die. Adult steelhead were kelts, and also did not die as a result of the screens. A total of 238 smolts were recovered dead on the screens during this analysis. Since the peak of the spring chinook migration occurred two weeks before the start of this analysis, this number is an under estimate of the impacts of this installation on the fishery resource. In addition, descaled fish may have survived the screen, but would be subject to increased predator induced mortality.

Electroshocking surveys took place in Sunnyside Canal after it was dewatered in November. There were five sites sampled from the headworks to 41 miles downstream, and no salmonids were captured.

Chandler Canal

As part of ongoing estimations of capture efficiency of Prosser Smolt Trap, 13 releases of spring chinook were made in Chandler Canal (Table 26). Survival ranged from 29.0 to 76.7%, with mean survival equal to 44.6%. To evaluate losses due to predation only, fish were released immediately downstream from the canal intake, and 100 meters upstream from the screens on April 30th and May 5th. When this release took place at night, survival was 27.7% higher for the fish released near the screens, and 17.6% higher when the fish were released during the day. Undoubtedly, there was some predation taking place in the 100 meters between the release site and the screens, however, it is clear that a substantial number of fish are lost from the time they enter the canal until they reach the screens. It is also clear that mortality is reduced when fish were released at night rather than during the day. It was observed that when fish are release as close as 100 meters from the screens, only 76.7% were captured in the smolt trap. Therefore, screen mortality alone was measured to be as high as 23.3%. However, wild fish that have not been handled will most likely survive at a somewhat higher rate.

Approximately one mile of Chandler Canal below the fish screens was

TABLE 26. SURVIVAL ESTIMATES FOR SPRING CHINOOK IN CHANDLER CANAL, 1984

RELEASE DATE	NUMBER RECAPTURED/NUMBER RELEASED	SURVIVAL (%)	COMMENTS
04/18/84	61/198	30.8	
04/15/84	69/129	53.5	
04/17/84	45/118	38.1	
04/20/84	103/167	61.7%	
04/27/84	123/215	57.2%	
04/29/84	46/138	33.3	
04/30/84	77/157	49.0	NIGHT RELEASE AT CANAL ENTRANCE
04/30/84	122/159	76.7	NIGHT RELEASE AT ROTARY SCREENS
05/05/84	88/216		DAY RELEASE AT CANAL ENTRANCE
05/05/84	67/115	58.3	DAY RELEASE AT ROTARY SCREENS
05/11/84	41/79	51.9	
05/15/84	46/100	46.0	
05/22/84	9/31	29.0	

MEAN CANAL ENTERANCE SURVIVAL = 44.6% 95% C.I. = 36.9% - 52.4%

electrofished on May 3,1984. A total of four spring chinook smolts were captured, indicating some fish were able to pass the screens. When the canal was dewatered in November, areas in front and behind the screens were electrofished to determine if chinook were being stranded. No salmonids were recovered in front of the screens, but 26 smallmouth bass, 2 largemouth bass, and one squawfish were captured in the 600 meters that were inventoried. The bass were all juveniles, with mean lengths of 94mn. In surveys conducted downstream from the screens, no salmonids were captured. Two smallmouth bass, mean length 195mm and 45 squawfish, mean length 437mm were captured in 300 meters surveyed.

Gleed Ditch

Personnel from the Washington Department of Fisheries electrofished 100 meters of canal below the fish screens in Gleed Ditch on October 17th. A removal method was employed, and raw data was supplied to the Yakima Indian Nation. A total of 15 spring chinook were captured, yielding a DeLury population estimate of 18 fish in the 100 meter section. Seventeen steelhead were captured, yielding an estimate of 18 fish.

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A P P E B D I X A

PROSSER SMOLT TRAP EFFICIENCY TESTS, 1984

Prosser Smolt Trap Efficiency Testing

Prosser Dam and Chandler Canal are located at river mile 47 well below spring chinook spawning and rearing areas on the Yakima River. If outmigrating smolts couldbeaccurately countedas they pass the dam, then the spring chinook production of the entire Yakima River system as well as the effect of enhancement measurescould beassessed.

The Chandler Canal diverts a fairly constant 1200-1400 cfs of water from the Yakima River at Prosser Dam, and flows unobstructed for about 1.5 miles. At this point a series of 10 rotary screens and a by pass pipe divert fish to a smolt trap. The efficiency with which outmigrating smolts are captured at this trap has never been accurately estimated primarily because fish must traverse a considerable length of canal before they can enter the trap, and because river discharge and therefore trapping efficiency varies dramatically during the smolt run.

Impacted by run off, releases from storage reservoirs and upstream irrigation demands, river discharge at Prosser dam can range from 12,000 to 2,200 cfs from March through June. Because the canal diversion is fairly constant, the percent of the river discharge spilled over the dam varies just as widely - from about 7-90% in 1984. Since the greater the percent spill, the smaller the percent of outmigrants that can enter the canal and be trapped, enumerating outmigrants requires repetitive releases and the development of a relationship between trapping efficiency and river discharge.

Marked fish spend a considerable period (median residence time was 3 days in 1984, although stragglers remained as long as 40 days) traversing the canal, an environment which differs substantially from the river. Relative structural heterogenity and habitat volume are much reduced in the canal, and the rotary screens may represent a unique cause of stress or physical trauma. Possibly because of impingement on the screens and/or predatory mortality, the intra-canal mortality rate is greater than that which occurs in the river. Therefore, in estimating trapping efficiencies at this site, allowance must be made for a distinct, intra-canal mortality rate.

Trapping efficiency was estimated as the ratio of the number of recaptures of fish released in the river to the number of fish available for capture during the 3-7 day "base period" after release. The number of fish available for capture was estimated by the product of the number of fish released in the river, the river survival rate, and a term representing the combined effects of intra-canal mortality and stress-induced migration lag.

The aforementioned approach entailed the following basic experimental protocal for all releases except the first. The night before release, vigorous, uninjured fish were removed from the trap and given a caudal fin clip and a distinctive freeze-brand. The brand designated whether fish were destined for release within the canal ("canal fish"), or in the river ("river fish") at points, 2.5 and 3.5 miles above the canal inlet ("2-mile" and "3-mile" releases respectively). Branded fish were held in **200** gal. plastic tanks which were continuously aerated-both before and during transit to the release sites--by a l/4 h.p. air compressor fitted with air stones. Surviving fish were released the following morning, between 0800 and 0900 hrs. Intra-canal releases were made at a point approximately 100 ft. below the inlet, where intake turbulence had dissipated and the possiblity of fish being involuntarily swept back into the river was minimal. River releases were exactly one mile apart, at points 2.0 and 3.0 miles above the Prosser boat ramp. River-released fish were released from a boat in the middle of the river, whereas canal releases were made from the sides of the canal. At all sites, only vigorous, actively swimning fish were released.

The goal of this effort was to determine a relationship between efficiency and river discharge for spring chinook. Specifically it was hoped a statistically significant relationship between efficiency and the mean percent discharge spilled (P.D.S.) during the base period could be developed.

Methods

Derivation of Estimator

With one exception, efficiencies were estimated over a 7-day base period by means of the following expression:

$$E_i = \frac{\quad}{R_{ri}\,(S_{ri})^x\,(C_{ci}/R_{ci})} \qquad \text{equation 1}$$

Where E_i = estimated percent trapping efficiency for the i^{th} release;

C_{ri} = total base period recaptures of river-released fish during the i^{th} release;

R_{ri} = the number of fish released in the river during the i^{th} release;

$(S_{ri})^x$ = river survival for the i^{th} release;

(S_{ri}) = river survival per mile of river traversed in the i^{th} release;

x = miles of river traversed;

(C_{ci}/R_{ci}) = an expression representing the percent of river fish that resumed migration during base period and, if entering the canal, survived passage through it in release i;

C_{ci} = the number of recaptures of fish released in the canal during base period in release i;

R_{ci} = the number of fish released in the canal in release i.

Assumptions, Justifications and Simplifications

Determination of Base Period. The base Period was restricted to seven days because it was felt that seven days was sufficient time for the bulk of a release to move into the trap (or over the dam), yet not so long a time as to include radically different P.D.S. values and efficiencies. (Over eight separate release times, 78 percent of all recaptures of canal-released fish, and 72 percent of all recaptures of river-released fish, occurred in the first week).

The base period was never reduced from seven days unless such a period would have entailed unacceptably wide fluctuations in P.D.S. The criterion for unacceptable fluctuation and subsequent base period truncation was set at 25 percent of the mean P.D.S; any period including a mean daily P.D.S.

differing from the mean of the entire period by 25 percent or more was truncated. It was necessary to truncate the base period for only one release, when the base period was shortened from seven days to three.

River Survival. "Two-mile" and "three-mile" releases were exactly one mile apart. Therefore, assuming that canal survival, duration of migration and trapping efficiency were equivalent for simultaneous 2- and 3-mile releases, the ratio of total percent recaptures for groups simultaneously released 3.5 and 2.5 miles above the canal should estimate the survival rate per mile in the river, Sri:

$$\frac{C_{3i}/R_{3i}}{C_{2i}/R_{2i}} = \frac{(R_{3i}\,(S_{ri})^{3.5}\,(S_{ci})\,E_i)/R_{3i}}{(R_{2i}\,(S_{ri})^{2.5}\,(S_{ci})\,E_i)/R_{2i}} \qquad \text{equation 2}$$

$$= (S_{ri})^{3.5}/(S_{ri})^{2.5} = S_{ri}$$

where Sri = river survival rate per mile for the i^{th} release;

S_{ci} = cumulative canal survival rate for the i^{th} release;

C_{2i} and C_{3i} = total recaptures of fish released at "two-mile" "three-mile release points, respectively, from the i^{th} release;

R_{2i} and R_{3i} = number of fish released at the two-mile and three-mile release points, respectively, on the i^{th} release;

and Ei = the mean efficiency for the period over which all fish from the ith release were recaptured.

Three simultaneous 2-and 3-mile releases were made in 1984. Estimating S_{ri} as in equation 2 above, the values 0.847, 1.497 and 1.369 were obtained. The most probable cause for such anomalous figures is that river mortality is quite low relative to the variability of trapping efficiency. If, due to random variability, the efficiency of a 3-mile release were substantially greater than a 2-mile release, small losses attributable to river mortality would be obscured.

As mortality per river mile was apparently too low to be detected by available techniques, it was considered negligible, and the river survival term was dropped from the efficiency expression.

Net Base Period M&ration Rate Through Canal.

The percent of river fish that resumed migration during the base period and, if entering the canal, survived passage through it was estimated by the ratio of base period recaptures of canal fish to the number of fish released in the canal:

$$\text{Net Base Period Migration Rate} = C_{ci}/R_{ci} \qquad \text{equation3}$$

where C_{ci} = base period recaptures of canal fish in release i;
R_{ci} = number of fish released in canal in release i.

This estimator is obviously true for canal fish because base period recaptures must rekpresent the portion of the fish resuming migration and surviving canal residence and transit:

$$\frac{C_{ci}}{R_{ci}} = (M_{ci})\,(S_{c,ci}) \qquad \text{equation 4}$$

where M_{ci} = the percent canal fish resuming migration during base period in release i;
$S_{c,ci}$ = net survival of canal residence and passage for canal fish through base period in release i;

Equation 3 applies to river fish if M_{ci} and $S_{c,ci}$ equal the corresponding figures for river fish, Mri and $S_{c,ri}$, or if the product of these variables is equal for canal and river fish. While there is some evidence that canal survival and base period migration rate may not be precisely equivalent for canal and river fish, the discrepancies between figures for the respective groups are such that the product is probably comparable. Base period migration rate. The temporal distribution of recaptures, and therefore the base-period migration rate is quite similar for canal and river fish. As mentioned, 78 percent of the recaptures of all canal-released fish and 72 percent of the captures of all river-released fish occurred in the first week. Three additional pieces of evidence suggest that the temporal recapture distribution of river-released fish is reasonably well reflected by canal released fish. The first is that the extra distance traversed by river fish may not of itself entail a significantly retarded recapture distribution. The second is that there is no evidence of a significant delay associated with smolts finding the canal inlet. The third is that, in 5 of 8 individually analyzed releases, the distribution of recaptures during and after the base period was not significantly different between canal and river fish.

A Kolmogorov-Smirov (KS) test of the recapture distributions of all 2-mile and 3-mile releases, as well as a test of all simultaneous 2-mile and 3-mile releases (which entail similar efficiencies), showed no significant differences. Thus, the extra mile that 3-mile fish travel on their way to the trap does not significantly delay their recapture distribution relative to 2-mile fish. It may also be reasonable to assume that the recapture distribution of fish released 2.5 or 3.5 miles above the canal might not, solely because of the extra distance involved, be significantly delayed relative to canal fish. The fact that branded hatchery spring chinook smolts in 1983 migrated an average of 5.9 to 7.0 miles per day in the Yakima River (Wasserman and Hubble, 1983) supports the contention that traveling an extra 2-3 miles might not substantially retard the recapture distribution.

A delay in the recapture distribution of river fish relative to canal fish might occur if migrating river fish encountered Prosser Dam, avoided being spilled over the top, but still had difficulty finding the canal entrance. This possibility was checked by a simultaneous release of smolts 100 feet inside the canal and in the river, approximately 200 feet upstream of the inlet, at a point where no visually perceptible current moved into the canal. If merely finding the entrance entailed a significant delay, there should be a significant difference in the temporal distribution of recaptures between these groups A KS Test of the temporal distribution of recaptures indicated no significant difference, even at the 0.2 level between these groups.

A series of 2 x 2 Chi Square analyses of the temporal distribution of recaptures during and after base period, of canal and river fish indicated that, in 5 of 8 instances, there was no significant difference between canal and river fish.

This analylsis suggests that the percent of river and canal fish migrating during the base period may be comparable, especially in light of the fact that the three exceptions can largely be explained as the result of post-base-period changes in efficiency that distorted the temporal recapture distribution.

Canal Survival. Net base period migration rate through the canal is, as mentioned, the product of rates of survival and migration. For canal fish, the survival term reflects both survival of canal passage and survival of up to a week's residence in the canal. For river fish, however, the term reflects transit of the canal and varying periods of residence in the river and the canal. As over 90% of migrant smolts move through the canal at night, the losses occurring during canal passage are probably equivalent for river and canal fish. The difficulties of negotiating the rotary screens, finding the bypass ports and avoiding visual predators (squawfish, bass, anglers, and birds) during a night passage should not differ because of migration being resumed inside or outside the canal. However, losses attributable to predation occurring before migration resumes may well be greater for canal fish, particularly on the day of release, when somewhat disoriented fish adjust to a new and apparently hazardous environment.

In two separate releases, the survival rate of chinook smolts released just above the by-pass was greater than the survival rate of fish released at the canal inlet. As mentioned, in two of 3 instances, the total percent of fish recaptured from releases 3 miles above the canal was greater than for fish released 2 miles above the canal. Together, these results suggest that the hazards of traversing 1.5 miles of canal are substantially greater than 1.0 miles of river. Presumably, such a difference is due to a greater effective predation rate in the canal. Whatever the cause, one may assume survival per unit time is lower in the canal than the river. Because canal fish reside in the canal continously until they migrate, their overall base period survival rate is undoubtedly lower than the comparable figure for river fish.

The magnitude of the difference in base period canal survival for canal and river fish is not known. One release, however, provides room for speculation. In an attempt to assess the impact of visual predators on disoriented and possibly debilitated smolts immediately after release, a group of smolts was released at the canal inlet at night, between 0000 and 0100 hours. Overall survival for these fish (total recaptures/number released) was 49 percent. Mean overall survival for all day-time canal releases was 42.9 percent (includes one release not used in efficiency calculations because of errors in reading brands from river fish). If the difference in base period canal survival between canal and river fish could be attributed mainly to the fact that canal fish must spend one full day familiarizing themselves with an strange and predator-filled canal environment, while river fish enjoy the relative safety of the river that first day, then the survival rates reported above would have some relevance. In such a case it would be reasonable to infer that base period canal survival for river fish would be on the order of six percent greater than for canal fish.

Although canal fish may have a larger migration tendency and a smaller canal survival rate than river fish, net migration rate may be quite comparable between groups because this term represents the product of base period migration and survival rates. To the extent that the relative magnitudes of these opposed inter-group differences in migration and survival rates are equal, the products of the terms will be equal. Evidence that canal fish have a higher base migration rate was provided by a pair of KS tests of the pooled temporal distribution of recaptures of all canal and river fish. One test, which included the day of release, showed a significant difference between canal and river fish, whereas the other, which excluded recaptures from the day of release, did not. The significance of the first test was attributable to more recaptures of canal fish the first day. Thus, relative to river fish, canal fish have a lower intra-canal survival rate and a higher base period migration tendency. The product of these terms is probably comparable between groups for canal fish.

Results

Appendix Table A.1 summerizes the main results of 1984 experiments, and raw data are included in Appendix Table A.2. Two points are evident from Table A.l. First, the range of PDS values is rather restricted, With only the upper end being reasonably well represented. Second, when steelhead smolts were released at the same time as spring chinook, the efficiency estimates for both species were almost identical.

Linear, log, power and exponential regressions of base period PDS on efficiency estimates for spring chinook releases were run. The data was best fit by an exponential relationship. This relationship was significant (alpha =0.0l) and accounted for 73,8% of the variablity among efficiency estimates (See Figure 1).

There is, however, a problem with this relationship. Predicted efficiency exceeds 100% when PDS is less than 42.3%. If, over the entire range of possible PDS values, the relationshi[between PDS and efficiency were not exponential, but rather sigmoidal, this apparent anomaly would be explained. Data from 1984 include no PDS values below 45.4 percent, which, assuming a sigmoidal rleationship between PDS and efficiency, would include the right and middle sections of a "true" plot. Such a truncated sample of sigmoidally related data pairs could be expected to yield a good fit to an exponential relationship.

There are, parenthetically, biological reasons to expect a sigmoidal relationship between PDS and efficiency. At low PDS, the depth of the water column as it spills over the dam is quite small. In addition, the thalweg of the river is shifted into the canal. If migrating smolts can sense and avoid shallow areas, and if their movements are affected by the thalweg, one would expect large numbers of migrants to enter the canal at low PDS values. Furthermore, if aversion to shallow areas and the directional impact of predominant currents are great enough, there is no reason to assume that essentially all the outmigrants would enter the canal only when no water was being spilled. At some point, the alternative (being spilled over the dam)

APPENDIX TABLE A.1 SUMMARY OF 1984 EFFICIENCY TESTS AT CHANDLER CANAL

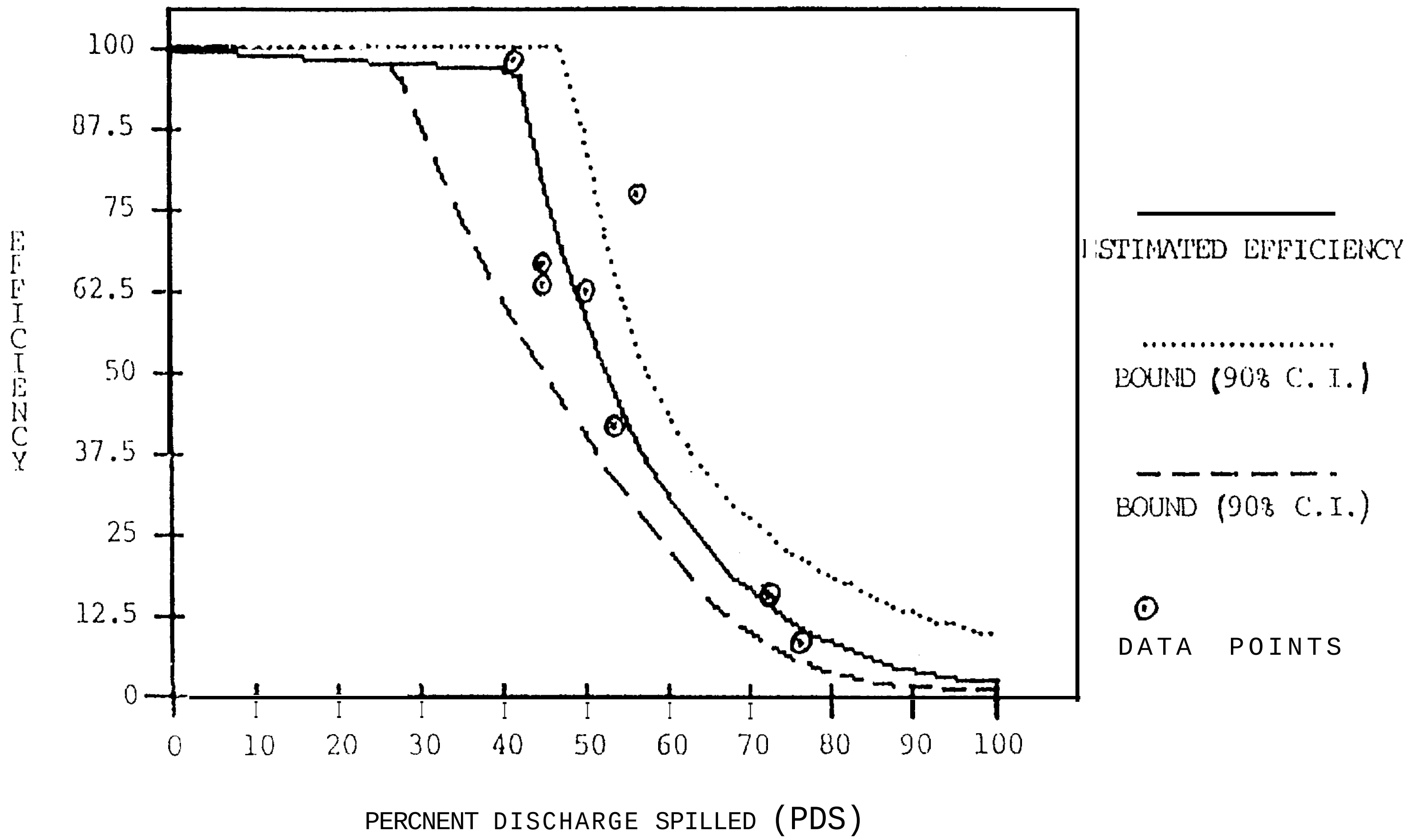
RELEASE NUMBER	SPECIES	DATE	NUMBER OF CANAL FISH RELEASED	NUMBER OF RIVER FISH RELEASED	BASE PERIOD LENGTH	BASE PERIOD PDS	EFFICIENCY
1.	SPRING CHINOOK	4/10/84	198	358	7 DAYS	54.5%	40.6
3.	SPRING CHINOOK	4/17/84	118	270	7 DAYS	59.5%	81.2
4.	SPRING CHINOOK	4/20/85	167	530	7 DAYS	56.2%	62.2
5.	SPRING CHINOOK	4/27/84	215	598	7 DAYS	46.1%	58.9
6.	SPRING CHINOOK	4/29/84	138	197	7 DAYS	46.8%	63.9
10.	SPRING CHINOOK	5/11/84	79	105	3 DAYS	45.4%	96.7
10.	STEELHEAD	5/11/84	70	120	3 DAYS	45.4%	91.1
11.	SPRING CHINOOK	5/15/84	100	95	7 DAYS	72.2%	17.1
11.	STEELHEAD	5/15/84	70	99	7 DAYS	72.2%	12.6
12.	SPRING CHINOOK	5/22/84	31	89	7 DAYS	74.4%	8.7

NOTE: Releases 2, 8 and 9 were exclusively intra-canal, while data from release 7 was discarded due to errors in brand reading.

APPENDIX TABLE A.2 RECAPTURES OF SPRING CHINOOK IN 1984 EFFICIENCY TESTS AT CHANDLER CANAL

RECAPTURE DAY	CANAL RECAPTURES											2-MILE RECAPTURES									3-MILE RECAPTURES			
	Release 1	Release 2	Release 3	Release 4	Release 5	Release 6	Release 9	Release 10	Release 11	Release 12	TOTAL	Release 1	Release 3	Release 4	Release 5	Release 6	Release 10	Release 11	Release 12	TOTAL	Release 1	Release 4	Release 5	TOTAL
1	45	15	9	45	54	17	33	9	13	3	243	8	15	29	26	7	6	3	0	94	5	29	25	59
2	11	4	6	11	19	7	9	11	9	1	88	6	4	10	19	13	16	0	1	69	6	24	26	56
3	3	18	5	6	11	1	2	1	7	1	55	8	9	3	14	4	5	2	0	45	4	8	17	29
4	0	5	6	3	8	1	3	3	2	0	31	0	7	7	8	1	3	1	1	28	1	4	12	17
5	0	2	0	1	2	2	2	7	0	2	18	2	6	3	1	2	8	0	0	22	1	11	1	13
6	1	1	2	5	5	0	7	3	3	0	27	2	6	2	9	0	0	0	0	19	1	6	8	15
7	0	4	0	6	6	6	3	2	3	0	30	0	5	2	3	4	4	0	0	18	0	14	3	17
8	0	1	5	6	0	4	9	0	4	0	29	1	1	6	1	6	2	0	0	17	2	14	3	19
9	0	0	4	6	3	1	3	0	2	0	19	1	2	4	7	4	1	0	0	19	0	8	4	12
10	1	9	0	3	1	1	3	0	0	1	19	4	7	2	1	2	1	0	0	17	0	4	1	5
11	0	1	1	5	1	0	1	0	1	0	10	0	2	0	1	1	0	0	0	4	1	5	7	13
12	0	3	0	0	1	1	6	2	0	0	13	0	2	0	1	6	0	0	0	9	0	1	3	4
13	0	2	1	4	1	0	2	3	0	0	13	0	0	0	0	0	1	0	0	1	0	4	3	7
14	0	1	2	0	1	0	1	0	1	0	6	0	2	0	4	0	2	0	0	8	0	2	3	5
15	0	0	0	0	0	2	0	0	0	0	3	0	0	1	0	1	0	0	0	2	0	1	1	2
16	0	0	0	0	0	0	1	0	0	0	2	0	1	0	3	1	0	0	0	5	0	2	0	2
17	0	0	0	0	1	1	0	0	1	0	2	0	0	3	2	2	0	0	0	7	0	1	1	2
18	0	0	0	0	1	1	1	0	0	0	3	0	1	1	0	1	0	0	0	3	0	1	0	1
19	0	0	0	0	3	3	0	0	0	0	3	0	0	0	1	0	0	0	0	1	0	0	2	2
20	0	0	2	0	1	1	0	0	0	0	3	0	1	0	0	2	0	0	0	3	0	1	0	1
21	0	1	1	0	0	0	0	0	0	0	2	0	0	1	1	0	0	0	0	2	0	0	0	0
22	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	2	0	1	0	1
23	0	0	0	1	1	1	0	0	0	0	2	0	0	0	0	2	0	0	0	2	0	2	2	4
24	0	1	0	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1
25	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	2	0	0	2	2
26	0	0	0	0	1	1	0	0	0	0	2	0	0	0	1	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
30	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
32	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

CORRECTED REGRESSION OF PDS ON EFFICIENCY



APPENDIX FIGURE A.1 MODIFIED EFFICIENCY AS A FUNCTION OF PDS

Chandler Canal, 1984

NOTE: The exponential relationship between PDS and efficiency broke down at low PDS values. Therefore, a linear relationship was assumed between 0 PDS, with an assumed efficiency of 100%, and the lowest PDS (and highest efficiency) actually observed. Upper bound of confidence interval was set at 100% whenever existing regression equation yielded a value for the upper bound greater then 100%. Lower bound of efficiency interval was set equal to predicted efficiency whenever regression equation yielded a value for the lower bound greater than predicted efficiency.

would beoome so unattractive, fish would "choose" to enter the canal.

The distribution of data collected in 1984 was too restricted to be fit to a sigmoidal model. It is hoped that this deficiency can be corrected in the 1985 field season. As an interim solution, a second, linear P.D.S.-efficiency relationship was developed. The highest estimated efficiency, 96.7%, was observed in the release that occasioned the lowest PDS--45.5%. In the absence of data for releases with mean PDS values in the 0 - 45% range, a straight line was drawn between the points (45.5, 96.7) and (0,100), where the x-values represent P.D.S. and the y-values efficiency (see Figure A.1). Efficiency was estimated by the linear expression if use of the exponential model indicated efficiencies were in excess of 96.7 percent.

ESTIMATION OF OUTMIGRATION

Daily outmigration was estimated by dividing actual smolt trap captures by the daily trapping efficiency. Daily trapping efficiency was calculated from the derived exponential relationship between P.D.S. and efficiency. A moving seven day average PDS was assigned to the captures of a given day because fish may not move entirely through the canal in a single day (median canal residence for canal fish = three days, 78% emigration of canal fish in seven days), and because the efficiency/P.D.S. relationship was, with one exception, based on seven day mean PDS values.

The exponential relationship previously described calculated by performing a simple linear regression of PDS on the natural log of efficiency. Straight-forward application of this expression therefore gives braised estimates of efficiency (geometric rather than arithmatic means). This lias was corrected by dividing estimates by $1+S_{est}$, where S_{est} = the standard error of estimate for the regression (D.C. Chapman, personal communication, 1984). Daily P.D.S. values were calculated as a seven day average of P.D.S.'s on the day for which efficiency was to be predicted and the previous six days.

APPENDIX TABLE B.1. CAPTURES OF SPRING CHINOOK FRY IN YAKIMA RIVER EMERGENCE TRAPS, 1984

CALENDAR DATE	JULIAN DATE	SUN COUNTRY TOTALS	SUN CNT. CUMS.	ELK MEADOWS TOTALS	ELK MEAD. CUMS.	EASTON TOTALS	EASTON CUMS.	RUN ACRES 9 TOTALS	RUN ACRES 9 CUMS.	RUN ACRES 10 TOTALSA	RUN ACRES 10 CUMS
840309	68	0	0	0	0	0	0	0	0	2	2
840312	71	0	0	0	0	1	1	0	0	0	2
840401	91	0	0	1	1	0	1	0	0	0	2
840402	92	0	0	1	2	0	1	1	1	0	2
840403	93	0	0	5	7	0	1	0	1	0	2
840404	94	14	14	6	13	0	1	0	1	0	2
840405	95	22	36	6	19	0	1	0	1	0	2
840406	96	138	174	3	22	1	2	0	1	0	2
840407	97	82	256	0	28	0	2	0	1	0	2
840408	98	34	290	0	28	0	2	0	1	0	2
840409	99	31	321	0	28	2	4	0	1	0	2
840410	100	29	350	5	33	0	4	0	1	0	2
840411	101	136	486	21	54	0	4	0	1	0	2
840412	102	80	566	18	72	0	4	0	1	0	2
840413	103	22	588	6	78	1	5	0	1	0	2
840414	104	8	596	14	92	0	5	0	1	0	2
840415	105	29	625	27	119	0	5	0	1	0	2
840416	106	3	628	70	189	2	7	0	1	0	2
840417	107	0	628	66	255	0	7	0	1	0	2
840418	108	3	631	50	305	1	8	0	1	0	2
840419	109	0	631	70	375	0	8	0	1	0	2
840421	111	0	631	16	391	3	11	0	1	0	2
840422	112	0	631	5	396	2	13	0	1	0	2
840423	113	2	633	6	402	1	14	0	1	0	2
840424	114	0	633	0	402	0	14	0	1	13	15
840425	115	0	633	0	402	0	14	0	1	15	30
840426	116	0	633	3	405	0	14	0	1	7	37
840427	117	0	633	0	405	0	14	0	1	27	64
840429	119	0	633	3	408	0	14	0	1	7	71
840501	121	0	633	8	416	0	14	0	1	62	133
840503	122	0	633	3	419	5	19	23	24	41	174
840504	124	0	633	3	422	0	19	104	128	28	202
840505	125	0	633	0	422	3	22	51	179	14	216
840507	127	0	633	0	422	4	26	123	302	94	310
840509	129	1	634	11	433	30	56	16	318	34	344
840513	133	0	634	0	433	258	314	30	348	91	435
840514	134	0	634	1	434	435	749	27	375	40	475
840515	135	0	634	0	434	24	773	6	381	11	486
840517	137	0	634	0	434	22	795	0	381	4	490
840518	138	0	634	0	434	4	799	3	384	3	493
840521	141	0	634	0	434	15	814	0	384	0	493
840524	144	0	634	0	434	12	826	9	393	2	495
840529	149	0	634	0	434	1	827	0	393	0	495
840604	155	0	634	0	434	3	830	3	396	2	497
840607	158	0	634	0	434	0	830	2	398	3	500
840611	162	0	634	0	434	1	831	0	398	5	505
840614	165	0	634	0	434	0	830	1	399	6	511

APPENDIX TABLE B. 2 PERCENT FINER THAN VALUES PER UNIT SAMPLES AT GIVEN SIEVE DIAMETERS
UPPER YAKIMA RIVER OCTOBER, 1983

	SIEVE DIAMTERS (MM)									
	75.0	26.5	13.2	9.5	6.7	3.25	1.70	.85	.425	.212	LT.312
RUNACRES #10	100.0	73.0	58.4	51.7	45.8	35.2	21.3	11.3	6.1	4.4	14.8
RUNACRES #9	97.3	70.0	52.2	45.6	39.3	28.1	16.9	11.4	7.6	5.5	13.0
ELK MEADOWS	89.4	63.6	42.2	35.4	29.8	21.6	13.7	11.4	10.3	9.4	18.3
EASTON	94.1	57.4	38.9	32.9	27.5	21.5	16.0	11.8	9.2	8.2	30.6
SUN COUNTRY	97.9	70.3	52.6	45.9	39.3	28.6	15.8	9.8	7.7	6.0	26.3

APPENDIX TABLE B.3 GRAVEL SAMPLES TAKEN FROM UPPER YAKIMA RIVER, 1983

GEOMETRIC DIAMETERS

	D5(MM)	D16(MM)	D50(MM)	D84(MM)	D95(MM)	%<.850
SUN COUNTRY	.51	1.44	6.97	33.76	94.77	.09
EASTON	.59	1.95	12.17	76.03	252.00	.07
ELK MEADOWS	.62	2.01	12.19	74.14	241.00	.07
RUNACRES #9	.51	1.44	7.01	34.16	96.00	.09
RUNACRES #10	.47	1.22	5.25	22.52	58.00	.11

D values are the sediment diameters of which the corresponding percentage of the sample is smaller than For example at Sun Country, 5% of the sample is smaller than .51mm.

APPENDIX TABLE B.4 NUMBER OF JUVENILE SPRING CHINOOK CAPTURED IN SEINING OPERATIONS ON THE YAKIMA RIVER, DECEMBER 1983 - OCTOBER, 1984

LOCATION	RIVER-MILE	DECEMBER N X %	MARCH N X %	APRIL N X %	MAY N X %	JUNE N X %	JULY N X %	AUGUST N X %	SEPTEMBER N X %	OCTOBER N X %
N.RICHLAND	8	N/A	N/A	5* 1.0 3	0	N/A	0	0	3 .6	0
BENTON	25	N/A	N/A	5* 1.0 3	0	N/A	0	0	0	0
PROSSER	44	N/A	24* 4 8 17	12* 2 4 7	0	N/A	0	0	0	0
GRANGER	82	N/A	46* 9.2 32	9* 1.8 5	0	9 1.8	7 1.4	0	0	0
TOPPENISH	95	4 .8	10* 2.0 7	7* 1.4 4	11* 2.2 12	6 1.2	0	0	1 .2 1	1 .4 11
SELAH	118	N/A	25* 5 0 17	3* .75 2	29 5 8 32	N/A	3 .6 1	12 2 4 4	1 .2 1	13 2 6 72
YAKIMA CANYON	135	N/A	38* 7 6 26	40* 8.0 50	45 9.0 50	N/A	135 27 61	24040 76	295.8 35	0
ELLENSBURG	152	N/A	0	11 2.2 6	0	N/A	27 5.4 12	15 3 5	48 9.6 58	2 .4 11
E-BURG CANYON	169	N/A	0	70 14.0 40	0	N/A	N/A	N/A	1 .2 1	0
CLE ELUM	181	2 . 4*	0	11 2.2 6	0	N/A	27 5.5 12	27 5. * 8	3 .6 4	1 .2 6
EASTON	195	N/A	0	0	5 .2 5	N/A	21 4.2 9	21 4.2	0	0
LOWER NACHES	9	N/A	1 .2 16	3 .6 50	3 .6 37	N/A	15 3.0 10	0	0	0
MIDDE NACHES	31	N/A	5 1.0 84	3 .6 50	5 1.0 63	N/A	43 8.6 29	31 6 2 30	15 3.0 29	0
UPPER NACHES	42	N/A	0	0	N/A	N/A	89 17.8 60	72 14.4 70	36 7.2 71	0

N=Number of Fish captured in 5 seine houls

X=Mean number per seine haul

%=Percentage of the total number of fish caught during the month that were captured at that site.

*=Indicates fish were 1+ all others are young of the year

APPENDIX TABLE B.5. DAILY CAPTURES OF SALMONIDS AT PROSSER SMOLT TRAP MARCH, 1984

DATE	WILD SP.CHK.	HATCHE R Y SP.CHK	NILE SPRI NGS	LEAV ENWO RTH	WILD SH	HATCHE RY SH	LAT(2)	LAT(4)[	WILD FALL CHK.	HATCHE RY FALL CHK.
840305	3	0	0	a	0	0	0	0	0	0
840607	6	0	0	0	1	0	0	0	0	0
840313	0	0	0	0	2	0	0	0	0	0
840314	4	0	0	0	2	0	0	0	0	0
840316	1	0	0	0	6	0	0	0	0	0
840319	11	0	0	0	11	0	0	0	0	0
840320	4	0	0	0	4	0	0	0	0	0
840321	14	0	0	0	17	0	0	0	0	0
a40322	27	0	0	0	30	0	0	0	0	0
840323	45	0	0	0	61	0	0	0	0	0
840324	33	0	0	0	39	0	0	0	0	0
840325	43	0	0	0	29	0	0	0	0	0
840326	47	0	0	0	32	0	0	0	0	0
840327	19	0	0	0	41	1	0	0	0	0
840328	27	0	0	0	64	0	0	0	0	0
840329	40	0	0	0	50	0	0	0	0	0
840330	55	0	0	0	98	0	0	0	0	0
840331	109	0	0	0	96	0	0	0	0	0
** TOTAL **	488	0	0	0	583	1	0	0	0	0

APPENDIX TABLE B.G. DAILY CAPTURES OF SAMONIDS AT PROSSER SMOLT TRAP APRIL 1984

DATE	WILD SP.CHK.	HATCHE R Y SP.CHK	NILE SPRI NCS	LEAV ENWO RTH	WILD SH	HATCHE RY SH	LAT(Z)	LAT(4)[	WILD FALL CHK.	HATCHE RY FALL CHK.
840401	la3	0	0	0	. 75	0	0	0	0	0
840402	246	0	0	0	150	0	0	0	0	0
840403	232	3	0	0	64	0	0	0	0	0
840404	433	0	0	0	152	0	0	0	0	0
840405	707	0	0	0	174	0	0	0	0	0
840406	892	0	0	0	154	0	0	0	0	0
840407	739	0	0	0	193	0	0	0	0	0
840408	671	0	0	0	178	0	0	0	0	0
840409	757	0	0	0	261	0	0	0	0	0
840410	662	0	0	0	199	0	0	0	0	0
840411	636	0	0	0	237	0	0	0	0	0
840412	522	0	0	0	187	0	0	0	0	0
840413	299	3	0	0	142	0	0	0	0	0
840414	294	0	0	0	231	0	0	0	0	0
840415	395	0	0	0	339	2	0	0	0	0
840416	1164	0	0	0	564	0	0	0	0	0
840417	3797	0	0	0	1008	0	0	0	0	0
840418	1734	31	0	0	943	9	0	0	0	0
840419	"260	112	21	0	856	122	0	0	0	0
840420	1853	146	13	3	830	354	141	197	0	0
840421	1426	116	16	8	856	325	223	78	0	0
a40422	984	74	5	1	746	353	lb5	161	0	0
840423	1275	138	40	31	833	503	265	213	0	0
840424	1425	197	81	82	523	397	203	18	0	0
840425	1254	202	68	43	659	341	179	155	0	0
840426	1551	267	75	9	624	376	182	168	0	0
840427	1954	240	28	6	715	297	142	136	0	0
840428	1234	185	29	6	630	226	86	101	0	0
840429	825	233	55	16	487	170	71	88	0	0
840430	935	308	85	26	1003	304	152	146	0	0
** TOTAL **	31339	2252	516	231	14013	3779	1809	1631	0	0

APPENDIX TABLE B .7, DAILY CAPTURES OF SALMONIDS AlL PROSSER SMOLT TRAP MAY, 1984

DATE	WILD SP.CHK.	HATCHE RY SP.CHK	NILE SPRI NGS	LEAV ENWO RTH	WILD SH	HATCHE RY SH	LAT(2)	LAT(4)[	WILD FALL CHK.	HATCHE RY FALL CHK.
840501	1103	256	36	12	791	245	124	121	0	0
840502	1738	441	70	15	936	200	98	84	0	0
840503	1515	505	79	14	955	136	56	56	0	0
940504	1832	621	82	29	1979	325	160	156	0	0
840505	1461	649	90	44	1914	399	211	179	0	0
840506	1054	521	71	32	1310	332	167	153	0	0
840507	566	250	41	21	844	209	111	91	0	0
840508	486	228	29	20	810	190	93	88	101	0
840509	688	257	35	19	880	164	78	67	145	0
840510	944	398	73	42	1085	174	92	65	197	0
340511	587	387	53	48	790	78	36	34	122	0
840512	843	511	66	43	1078	150	67	72	176	0
840513	581	270	50	17	728	137	65	50	121	0
840514	762	185	25	21	920	123	64	54	159	0
840515	1628	368	52	69	1308	230	110	94	382	0
840516	1653	588	68	75	760	221	81	67	389	0
840517	1401	464	59	50	542	145	64	57	329	0
840518	1075	320	12	66	318	33	17	9	252	0
840519	1095	333	11	44	364	19	8	10	257	0
840520	738	242	20	29	262	20	9	9	173	a
840521	534	159	5	19	143	5	3	1	147	0
840522	347	i46	7	26	107	4	1	2	213	0
840523	270	105	6	14	106	6	1	5	166	0
840524	242	54	1	5	151	0	0	0	148	0
840525	196	69	0	6	76	2	0	2	121	0
840526	281	53	5	7	181	5	2	2	173	0
840527	158	37	1	3	128	2	2	0	98	0
840528	700	33	1	7	139	5	1	3	430	0
840529	614	22	0	4	124	4	0	1	377	0
840530	1174	72	2	a	193	9	3	4	721	0
840531	189	17	1	3	50	5	2	2	116	0
** TOTAL **										
	26505	8561	1051	812	19972	3577	1726	1538	5513	0

APPENDIX TABLE B .8 . DAILY CAPTURES OF SALMONIDS AT PROSSER SMOLT TRAP JUNE, 1984

DATE	WILD SP.CHK.	HATCHIE RY SP.CHK	MILE SPRI NGS	LEAV ENWO RTH	WILD SH	HATCHIE RY SH	LAT(2)	LAT(4)[	WILD FALL CHK.	HATCHIE RY FALL CHK.
840601	102	27	1	0	92	4	4	0	241	0
840602	115	17	0	2	93	1	1	0	195	0
840603	113	8	0	0	108	10	2	5	187	0
840604	185	21	1	3	92	19	13	3	315	0
040505	156	9	0	0	69	7	3	3	266	0
840606	42	8	0	0	25	2	1	0	72	0
840607	45	1	1	0	13	0	0	0	77	0
840608	12	1	0	0	6	0	0	0	63	0
840609	9	1	0	1	9	0	0	0	45	0
840610	15	0	0	0	6	0	0	0	76	0
840611	13	0	0	0	3	0	0	0	69	0
840612	32	0	0	0	7	0	0	0	167	0
840613	21	0	0	0	16	0	0	0	108	0
840614	GO	1	0	0	11	3	0	0	318	0
340615	73	1	0	0	18	0	0	0	227	0
840616	16	0	0	0	8	1	0	1	51	0
840617	3	0	0	0	6	0	0	3	9	0
840618	1	0	0	0	0	0	0	0	2	0
840619	4	0	0	0	0	0	0	0	13	0
840620	10	0	0	0	2	2	0	0	31	2
840621	6	0	0	3	2	0	0	0	18	0
840622	3	0	0	0	0	0	0	0	12	[illegible]
840623	0	0	0	0	0	0	0	0	5	0
840624	0	0	0	0	0	0	0	0	72	3
840625	0	0	0	0	0	0	0	0	[illegible]	1
840626	0	0	0	0	0	0	0	0	1	1
840627	0	0	0	0	0	0	0	0	0	1
840628	0	0	0	0	0	0	0	0	0	0
840629	0	0	0	0	0	0	0	0	2	[illegible]
[illegible]30	0	0	0	[illegible]	0	0	0	0	[illegible]	80
** TOTAL **										
	103:	95	3	6	576	46	24	12	2651	137

APPENDIX TABLE B.9. DAILY CAPTURES OF SALMONIDS AT PROSSER SMOLT TRAP JULY, 1984

DATE	WILD SP.CHK.	HATCHERY SP.CHK.	NILE SPRINGS	LEAVENWORTH	WILD SH	HATCHERY SH	LAT(2)	LAT(4)[	WILD FALL CHK.	HATCHERY FALL CHK.
840701	0	0	0	0	0	0	0	0	11	100
840702	0	0	0	0	0	0	0	0	28	297
840703	0	0	0	0	0	0	0	0	31	442
840704	0	0	0	0	13	0	0	0	31	954
840705	0	0	0	0	8	0	0	0	30	1012
840706	0	0	0	0	1	0	0	0	31	2673
840707	0	0	0	0	2	0	0	0	43	1963
840708	0	0	0	0	0	0	0	0	100	596
840709	0	0	0	0	0	0	0	0	60	1263
840710	0	0	0	0	1	0	0	0	74	1146
840711	0	0	0	0	1	0	0	0	61	1133
840712	0	0	0	0	3	0	0	0	19	522
840713	0	0	0	0	1	0	0	0	48	454
840714	0	0	0	0	0	0	0	0	39	434
840715	0	0	0	0	1	0	0	0	49	805
840716	0	0	0	0	0	0	0	0	2	314
840717	0	0	0	0	0	0	0	0	31	307
840718	0	0	0	0	0	0	0	0	59	404
840719	0	0	0	0	0	0	0	0	26	269
840720	0	0	0	0	0	0	0	0	9	198
840721	0	0	0	0	1	0	0	0	26	116
840722	0	0	0	0	0	0	0	0	20	187
840723	0	0	0	0	0	0	0	0	31	185
840724	0	0	0	0	0	0	0	0	11	7
840725	0	0	0	0	0	0	0	0	7	0
840726	0	0	0	0	0	0	0	0	14	73
840727	0	0	0	0	0	0	0	0	11	41
840728	0	0	0	0	0	0	0	0	4	51
840729	0	0	0	0	0	0	0	0	7	17
840730	0	0	0	0	0	0	0	0	0	10
840731	0	0	0	0	0	0	0	0	1	7
** TOTAL **	0	0	0	0	32	0	0	0	914	15980

APPENDIX TABLE B.10. DAILY ESTIMATED PASSAGE OF CHINOOK SMOLTS TO PROSSER WITH 90% CONFIDENCE LIMITS MARCH, 1984

DATE	# WILD S-CHK	LB WILD S-CHK	UB WILD S-CHK	# HACH S-CHK	LB HACH S-CHK	UB HACH S-CHK	# NILE	LB NILE	UB NILE	# ENTIAT	LB ENTIAT	UB ENTIAT	# WILD F-CHK	LB WILD F-CHK	UB WILD F-CHK	# HACH F-CHK	LB HACH F-CHK	UB HACH F-CHK	# LA21	LB LA21	UB LA21
65	51	20	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	42	18	103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	61	30	127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	37	20	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	29	17	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	23	15	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	21	14	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	20	13	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	20	13	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	17	11	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	8	5	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	4	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	28	18	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	29	19	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	55	35	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	20	12	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	74	46	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	166	98	278	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	319	180	569	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	264	141	492	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	373	194	716	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	443	222	886	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	193	94	404	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	287	137	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	400	196	816	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	509	257	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91	923	484	1758	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
** TOTAL **	4416	2312	8497	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

S-chk = Spring Chinook
STH = Steelhead
LB = Lower Bound
Hach s-chk = Hatchery Spring Chinook
F-chk = Fall Chinook
UB = Upper Bound

APPENDIX TABLEB.ll. DAILY ESTIMATED PASSAGE OF CHINOOK SMOLTS TO PROSSER WITH 90% CONFIDENCE LIMITS APRIL, 1984

DATE	# WILD S-CHK	LB WILD S-CHK	UB WILD S-CHK	# HACH S-CHK	LB HACH S-CHK	UB HACH S-CHK	# NILE	LB NILE	UB NILE	# ENTIAT	LB ENTIAT	UB ENTIAT	# WILD F-CHK	LB WILD F-CHK	UB WILD F-CHK	# HACH F-CHK	LB HACH F-CHK	UB HACH F-CHK	# LA21	LB LA21	UB LA21
92	1418	772	2614	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	1720	980	3037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	1459	862	2468	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	2418	1498	3936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	3535	2266	5480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	4018	2662	6027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	3016	2058	4425	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	2476	1733	3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	2566	1824	3604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	2062	1434	2865	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102	1876	1358	2595	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103	1462	1063	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	788	575	1083	7	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	727	528	996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106	918	667	1266	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107	2592	1871	3581	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108	8668	6276	11977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109	4099	2974	5629	73	53	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	5607	4086	7713	277	202	382	52	37	71	0	0	0	0	0	0	0	0	0	0	0	0
111	4876	3556	6689	384	280	527	34	24	46	7	5	10	0	0	0	0	0	0	0	0	0
112	3972	2892	5463	323	235	444	44	32	61	22	16	30	0	0	0	0	0	0	0	0	0
113	2928	2120	4049	220	159	304	14	10	20	2	2	4	0	0	0	0	0	0	0	0	0
114	3984	2871	5543	431	310	600	125	90	173	96	69	134	0	0	0	0	0	0	0	0	0
115	4318	3218	5962	596	431	824	245	177	333	248	179	343	0	0	0	0	0	0	0	0	0
116	3445	2502	4732	554	403	762	186	135	256	118	a5	162	0	0	0	0	0	0	0	0	0
117	3829	2784	5257	659	479	905	la5	134	254	22	16	30	0	0	0	0	0	0	0	0	0
118	4391	3177	6068	539	390	745	62	45	86	13	9	18	0	0	0	0	0	0	0	0	0
119	2472	1760	3466	370	263	519	58	41	81	12	8	16	0	0	0	0	0	0	0	0	0
120	1437	995	2078	405	281	586	95	66	138	27	19	40	0	0	0	0	0	0	0	0	0
121	1425	351	2134	469	313	703	129	86	194	39	26	59	0	0	0	0	0	0	0	0	0
** TOTAL **	88502	62263	126302	5307	3804	7411	1229	877	1718	606	434	846	0	0	0	0	0	0	0	0	0

S-chk = Spring Chinook

Hach s-chk = Hatchery Spring Chinook

STH = Steelhead

F-chk = Fall Chinook

LB = Lower Eound

UB = Upper Eound

APPENDIX TABLEB.12, DAILY ESTIMATED PASSAGE OF CHINOOK SMOLTS TO PROSSER WITH 90% CONFIDENCE LIMITS MAY, 1984

DATE	# WILD S-CHK	LB WILD S-CHK	UB WILD S-CHK	# HACH S-CHK	LB HACH S-CHK	UB HACH S-CHK	# NILE	LB NILE	UB NILE	# ENTIAT	LB ENTIAT	UB ENTIAT	# WILD F-CHK	LB WILD F-CHK	UB WILD F-CHK	# HACH F-CHK	LB HACH F-CHK	UB HACH F-CHK	# LA21	LB LA21	UB LA21
122	1506	1103	2331	349	256	541	49	36	76	16	12	25				0	0	0	0	0	0
123	2254	1738	3554	571	441	901	90	70	143	19	15	30	0			0	0	0	0	0	0
124	1990	1515	3123	663	505	1041	103	79	162	18	14	28	0	0		0	0	0	0	0	0
125	2442	1832	3816	828	621	1293	109	82	170	38	23	60		0		0	0	0	0	0	0
126	2001	1461	3095	889	649	1375	123	90	190	60	44	93	0		0	0	0	0	0	0	0
127	1501	1054	2296	742	521	1135	101	71	154	45	32	63	0		0	0	0	0	0	0	0
128	825	566	1252	364	250	553	59	41	90	30	21	46	0	0	0	0	0	0	0	0	0
129	702	486	1068	329	228	501	41	29	63	28	20	43	145	101	221	0	0	0	0	0	0
130	346	688	1463	353	257	546	48	35	74	26	19	40	199	145	308	0	0	0	0	0	0
131	1174	944	1876	495	333	791	90	73	145	52	42	83	245	197	391	0	0	0	0	0	0
132	607	587	1091	400	387	719	54	53	98	49	48	89	126	122	226	0	0	0	0	0	0
133	870	843	1484	527	511	899	68	66	116	44	43	75	181	176	309	0	0	0	0	0	0
134	600	581	1071	279	270	498	51	50	92	17	17	31	125	121	223	0	0	0	0	0	0
135	965	762	1533	234	185	372	31	25	50	26	21	42	201	159	319	0	0	0	0	0	0
136	2584	1746	3821	584	334	863	a2	55	122	109	74	161	606	409	896	0	0	0	0	0	0
137	3502	2519	4876	1245	836	1734	144	103	200	158	114	221	824	592	1147	0	0	0	0	0	0
138	4002	2906	5515	1325	962	1826	168	122	232	142	103	196	940	682	1295	0	0	0	0	0	0
139	4103	2843	5906	1221	846	1758	45	31	65	251	174	362	961	666	1384	0	0	cl	0	0	0
140	5530	3532	8622	1681	1074	2622	55	35	86	222	141	346	1297	323	2023	0	0	0	0	0	0
141	4341	2626	7165	1423	861	2349	117	71	194	170	103	281	1017	615	1679	0	0	0	0	0	0
142	3945	2272	6870	1074	618	1870	33	19	58	128	73	223	993	571	1729	0	0	0	0	0	0
143	2551	1422	4565	1073	598	1921	51	28	92	191	106	342	1566	872	2802	0	0	0	0	0	0
144	2061	1134	3802	801	441	1478	45	25	84	106	58	197	1267	697	2338	0	0	0	0	0	0
145	1890	1029	3507	421	229	782		4	14	39	21	72	1156	623	2144	0	0	0	0	0	C
146	1555	841	2882	547	296	1014		0	0	47	25	83	960	519	1779	0	0	0	0	0	(
147	2284	1221	4257	430	230	803	40	21	75	56	30	106	1406	752	2621	0	0	0	0	0	(
148	1284	636	2333	300	160	560	a	4	15	24	13	45	796	426	1484	0	0	0	0	0	'
149	5426	2966	10000	255	139	471		4	14	54	29	100	3333	1822	6142	0	0	0	0	0	
150	4481	2495	7914	160	83	285	0	0	0	29	16	51	2751	1532	4896	0	0	0	0	0	
151	8209	4658	14493	503	285	888	13	7	24	55	31	98	5041	2861	8901	0	0	0	0	0	
152	1350	759	2332	121	68	215		4	12	21	12	37	828	465	1468	0	0	0	0	0	
• ✉ TOTAL **	77481	49815	128093	20187	13665	32604	1839	1333	2310	2270	1500	3680	26964	15960	46725	0	0	0	0	0	

S-chk = Spring Chinook
STH = Steelhead
LB = Lower Bound

Hach s-chk = Hatchery Spring Chinook
F-chk = Fall Chinook
UB = Upper Bound

APPENDIX TABLE B.13. DAILY ESTIMATED PASSAGE OF CHINOOK SMOLTS TO PROSSER WITH 90% CONFIDENCE LIMITS JUNE, 1984

MTE	# WILD S-CHK	LB WILD S-CHK	UB WILD S-CHK	# HACH S-CHK	LB HACH S-CHK	UB HACH S-CHK	# NILE	LB NILE	UB NILE	# ENTIAT	LB ENTIAT	UB ENTIAT	# WILD F-CHK	LB WILD F-CHK	UB WILD F-CHK	# HACH F-CHK	LB HACH F-CHK	UB HACH F-CHK	# LA21	LB LA21	UB LA21
153	750	418	1342	198	110	355	7	4	13	0	0	0	1772	987	3171	0	0	0	0	0	0
154	839	467	1493	124	69	220	0	0	0	14	8	25	1423	792	2532	0	0	0	0	0	0
155	758	433	1325	55	31	96	0	0	0	0	0	0	1289	736	2253	0	0	0	0	0	0
156	1201	703	2055	136	79	233	6	3	11	19	11	33	2045	1197	3500	0	0	0	0	0	0
157	1040	600	1793	60	34	103	0	0	0	0	0	0	1773	1023	3057	0	0	0	0	0	0
158	300	168	531	57	32	101	0	0	0	0	0	0	514	289	911	0	0	0	0	0	0
159	326	182	584	7	4	12	7	4	12	0	0	0	557	313	1000	0	0	0	0	0	0
160	88	49	160	7	4	13	0	0	0	0	0	0	466	259	840	0	0	0	0	0	0
161	71	38	132	7	4	14	0	0	0	7	4	14	357	192	661	0	0	0	0	0	0
162	131	68	254	0	0	0	0	0	0	0	0	0	666	345	1238	0	0	0	0	0	0
163	127	63	260	0	0	0	0	0	0	0	0	0	676	334	1380	0	0	0	0	0	0
164	326	159	680	0	0	0	0	0	0	0	0	0	1704	030	3553	0	0	0	0	0	0
165	205	101	411	0	0	0	0	0	0	0	0	0	1058	521	2117	0	0	0	0	0	0
166	555	281	1090	9	4	18	0	0	0	0	0	0	2944	1492	5781	0	0	0	0	0	0
167	651	334	1258	8	4	17	0	0	0	0	0	0	2026	1041	3913	0	0	0	0	0	0
168	142	73	280	0	0	0	0	0	0	0	0	0	455	235	894	0	0	0	0	0	0
169	28	14	57	0	0	0	0	0	0	0	0	0	85	42	173	0	0	0	0	0	0
170	10	5	21	0	0	0	0	0	0	0	0	0	20	10	43	0	0	0	0	0	0
171	44	20	95	0	0	0	0	0	0	0	0	0	146	68	309	0	0	0	0	0	0
172	120	54	263	0	0	0	0	0	0	0	0	0	373	169	815	24	10	52	0	0	0
173	77	34	176	0	0	0	0	0	0	0	0	0	233	102	529	0	0	0	0	0	0
174	42	17	100	0	0	0	0	0	0	0	0	0	171	71	400	57	23	133	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0	76	31	192	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	1161	464	2880	0	0	0	0	0	0
177	0	0	0	0	0	0	0	0	0	0	0	0	16	6	43	16	6	43	0	0	0
178	0	0	0	0	0	0	0	0	0	0	0	0	17	6	45	17	6	45	0	0	0
179	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	6	50	0	0	0
180	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	38	14	105	923	338	2526	230	84	631
182	0	0	0	0	0	0	0	0	0	0	0	0	145	55	380	1454	551	3809	690	262	1809
** TOTAL **	7831	4281	14360	668	375	1182	20	11	36	40	23	72	22206	11624	42765	2509	940	6658	920	346	2440

S=chk = Spring Chinook

STH = Steelhead

LB = Lower Bound

Hach s-chk = Hatchery Spring Chinook

F-chk = Fall Chinook

UB = Upper Bound

APPENDIX TABLE B.14 DAILY ESTIMATED PASSAGE OF CHINOOK SMOLTS TO PROSSER WITH 90% CONFIDENCE LIMITS JULY, 1984

DATE	# WILD S-CHK	LB WILD S-CHK	UB WILD S-CHK	# HACH S-CHK	LB HACH S-CHK	UB HACH S-CHK	# NILE	LB NILE	UB NILE	# ENTIAT	LB ENTIAT	UB ENTIAT	# WILD F-CHK	LB WILD F-CHK	UB WILD F-CHK	# HACH F-CHK	LB HACH F-CHK	UB HACH F-CHK	# LA21	LB LA21	UB LA21
183	0	0	0	0	0	0	0	0	0	0	0	0	186	72	478	1694	657	4347	1288	500	3304
184	0	0	0	0	0	0	0	0	0	0	0	0	424	173	1037	4500	1844	11000	954	391	2333
185	0	0	0	0	0	0	0	0	0	0	0	0	418	180	968	5972	2569	13812	1702	732	3937
186	0	0	0	0	0	0	0	0	0	0	0	0	352	163	756	10840	5021	23266	11363	5263	24390
187	0	0	0	0	0	0	0	0	0	0	0	0	265	136	508	8955	4600	17152	4044	2077	1745
188	0	0	0	0	0	0	0	0	0	0	0	0	203	118	352	17585	10202	30375	1164	675	2011
189	0	0	0	0	0	0	0	0	0	0	0	0	195	129	294	8922	5094	13445	3395	2243	5116
190	0	0	0	0	0	0	0	0	0	0	0	0	297	215	411	1773	1284	2452	2675	1937	3699
191	0	0	0	0	0	0	0	0	0	0	0	0	114	81	162	2414	1706	3422	483	341	685
192	0	0	0	0	0	0	0	0	0	0	0	0	89	74	144	1389	1146	2242	214	177	346
193	0	0	0	0	0	0	0	0	0	0	0	0	62	61	92	1166	1133	1714	129	126	190
194	0	0	0	0	0	0	0	0	0	0	0	0	19	19	23	534	522	635	52	51	62
195	0	0	0	0	0	0	0	0	0	0	0	0	48	43	49	463	454	463	155	152	155
196	0	0	0	0	0	0	0	0	0	0	0	0	39	39	39	441	434	441	141	139	141
197	0	0	0	0	0	0	0	0	0	0	0	0	49	49	49	818	805	818	64	63	64
198	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	319	314	319	13	13	13
199	0	0	0	0	0	0	0	0	0	0	0	0	31	31	31	311	307	311	90	89	90
200	0	0	0	0	0	0	0	0	0	0	0	0	59	59	59	410	404	410	218	215	218
201	0	0	0	0	0	0	0	0	0	0	0	0	26	26	26	272	269	272	346	342	346
202	0	0	0	0	0	0	0	0	0	0	0	0	9	9	9	200	198	200	127	126	127
203	0	0	0	0	0	0	0	0	0	0	0	0	26	26	26	117	116	117	256	253	256
204	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	189	187	189	25	25	25
205	0	0	0	0	0	0	0	0	0	0	0	0	31	31	31	187	185	187	153	152	153
206	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	7	7		204	202	204
207	0	0	0	0	0	0	0	0	0	0	0	0	7	7	7	0	0	0	130	129	130
208	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	73	73	73	0	0	0
209	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	41	41	41	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	51	51	51	0	0	0
211	0	0	0	0	0	0	0	0	0	0	0	0	7	7	7	17	17	17	38	38	38
212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	0	0	0
213	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	7	7		0	0	0
TOTAL **		0	0	0	0	0	0	0	0	0	0	0	3019	1816	562[illegible]	69677	40457	127797	29423	16451	55778

S-chk = Spring Chinook

STH = Steelhead

LB = Lower Bound

Hach s-chk = Hatchery Spring Chinook

F-chk = Fall Chinook

UB = Upper Bound

APPENDIX TABLE B. 15. DAILY ESTIMATED PASSAGE OF STEELHEAD AND COHO OUTMIGRANTS TO PROSSER WITH 90% CONFIDENCE LIMITS MARCH, 1984

DATE	# WILD STH	LB WILD STH	UB WILD STH	# HACH STH	LB HACH STH	UB HACH STH	# LAT2 HACH STH	LB LAT2 HACH STH	UB LAT2 HACH STH	# LAT4 HACH STH	LB LAT4 HACH STH	UB LAT4 HACH STH	# COHO	LB COHO	UB COHO
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	14	6	34	0	0	0	0	0	0	0	0	0	0	0	0
67	10	5	21	0	0	0	0	0	0	0	0	0	0	0	0
68	15	8	27	0	0	0	0	0	0	0	0	0	0	0	0
69	11	7	19	0	0	0	0	0	0	0	0	0	0	0	0
70	9	6	14	0	0	0	0	0	0	0	0	0	0	0	0
71	8	5	12	0	0	0	0	0	0	0	0	0	0	0	0
72	a	5	11	0	0	0	0	0	0	0	0	0	0	0	0
73	8	5	12	0	0	0	0	0	0	0	0	0	0	0	0
74	8	5	12	0	0	0	0	0	0	0	0	0	0	0	0
75	17	11	26	0	0	0	0	0	0	0	0	0	0	0	0
76	27	18	41	0	0	0	0	0	0	0	0	0	0	0	0
77	38	24	58	0	0	0	0	0	0	0	0	0	0	0	0
78	39	25	61	0	0	0	0	0	0	0	0	0	0	0	0
79	55	35	87	0	0	0	0	0	0	0	0	0	0	0	0
80	20	12	32	0	0	0	0	0	0	0	0	0	0	0	0
81	90	56	144	0	0	0	0	0	0	0	0	0	0	0	0
82	185	109	309	0	0	0	0	0	0	0	0	0	0	0	0
83	432	244	772	0	0	0	0	0	0	0	0	0	0	0	0
84	312	lb7	582	0	0	0	0	0	0	0	0	0	0	0	0
85	252	131	483	0	0	0	0	0	0	0	0	0	0	0	0
86	301	151	603	0	0	0	0	0	0	0	0	0	0	0	0
87	418	203	872	0	0	0	0	0	0	0	0	0	0	0	0
88	680	324	1422	0	0	0	0	0	0	0	0	0	0	0	0
89	500	245	1020	0	0	0	0	0	0	0	0	0	0	0	0
90	907	457	1781	0	0	0	0	0	0	0	0	0	0	0	0
91	813	426	1548	0	0	0	0	0	0	0	0	0	0	0	0
** TOTAL **	5177	2690	10003	0	0	0	0	0	0	0	0	0	0	0	0

STH = Steelhead   Hach = Hatchery

Lat2 = Brand Group 1   Lat4 = Brand Group 2

LB = Lower Bound   UB = Upper Bound

APPENDIX TABLEB.16. DAILY ESTIMATED PASSAGE OF STEELHEAD AND COHO OUTMIGRANTS TO PROSSER WITH 90% CONFIDENCE LIMITS APRIL, 1984

DATE	# WILD STH	LB WILD STH	UB WILD STH	# HACH STH	LB HACH STH	UB HACH STH	# LAT2 HACH STH	LB LAT2 HACH STH	UB LAT2 HACH STH	# LAT4 HACH STH	LB LAT4 HACH STH	UB LAT4 HACH STH	# COHO	LB COHO	UB COHO
92	581	316	1071	0	0	0	0	0	0	0	0	0	0	0	0
93	1048	597	1851	0	0	0	0	0	0	0	0	0	0	0	0
94	402	237	680	0	0	0	0	0	0	0	0	0	0	0	0
95	849	525	1381	0	0	0	0	0	0	0	0	0	0	0	0
96	870	557	1348	0	0	0	0	0	0	0	0	0	0	0	0
97	693	459	1040	0	0	0	0	0	0	0	0	0	0	0	0
98	787	537	1155	0	0	0	0	0	0	0	0	0	0	0	0
99	656	459	941	0	0	0	0	0	0	0	0	0	0	0	0
100	884	628	1242	0	0	0	0	0	0	0	0	0	0	0	0
101	619	446	861	0	0	0	0	0	0	0	0	0	0	0	0
102	699	506	967	0	0	0	0	0	0	0	0	0	0	0	0
103	523	380	722	0	0	0	0	0	0	0	0	0	0	0	0
104	374	273	514	0	0	0	0	0	0	0	0	0	0	0	0
105	571	415	783	0	0	0	0	0	0	0	0	0	0	0	0
106	788	572	1086	4	3	6	0	0	0	0	0	0	0	0	0
107	1256	906	1735	0	0	0	0	0	0	0	0	0	0	0	0
108	2301	1666	3179	0	0	0	0	0	0	0	0	0	0	0	0
109	2229	1617	3061	21	15	29	0	0	0	0	0	0	0	0	0
110	2124	1547	2921	302	220	416	0	0	0	0	0	0	0	0	0
111	2184	1593	2996	931	679	1277	371	270	509	518	378	711	0	0	0
112	2384	1736	3279	905	659	1245	621	452	854	217	158	298	0	0	0
113	2220	1607	3069	1050	760	1452	491	355	679	479	346	662	0	0	0
114	2603	1876	3621	1571	1132	2186	828	596	1152	665	479	926	0	0	0
115	1584	1144	2188	1203	868	1661	615	444	849	569	411	786	0	0	0
116	1810	1315	2486	936	680	1286	491	357	675	425	309	584	0	0	0
117	1540	1120	2115	928	675	1274	449	326	616	414	301	569	0	0	0
118	1606	1162	2220	667	482	922	319	230	440	305	221	422	0	0	0
119	1262	898	1769	452	322	634	1'72	122	241	202	144	283	0	0	0
120	848	587	1226	296	205	428	123	85	178	153	106	221	0	0	0
121	1528	1020	2289	463	309	694	231	154	3.17	222	148	333	0	0	0
** TOTAL *	37823	26731	53796	9729	7009	13510	4711	3331	6540	4169	3001	5795	0	0	0

STH = Steelhead   Hach = Hatchery

Lat2 = Brand Group 1   Lat4 = Brand Group 2

LB = Lower Bound   UB = Upper Bound

APPENDIX TABLE B.17. DAILY ESTIMATED PASSAGE OF STEELHEAD AND COHO OUTMIGRANTS TO PROSSER WITH 90% CONFIDENCE LIMITS MAY, 1984

DATE	# WILD STH	LB WILD STH	UB WILD STH	# HACH STH	ID HACH STH	UB HACH STH	# LAT2 HACH STH	LB LAT2 HACH STH	UB LAT2 HACH STH	# LAT4 HACH STH	LB LAT4 HACH STH	UB LAT4 HACH STH	# COHO	LB COHO	UB COHO
122	1080	731	1672	331	245	517	169	124	262	165	121	255	0	0	0
123	1214	936	1914	259	200	408	127	98	200	103	84	171	0	0	0
124	1254	955	1969	178	136	280	73	56	115	73	56	115	0	0	0
125	2638	1979	4122	433	325	677	213	160	333	208	156	325	0	0	0
126	2621	1914	4055	546	399	845	289	211	447	245	179	379	8	6	12
127	1866	1310	2854	472	332	723	237	167	363	217	153	333	5	4	8
128	1230	844	1867	304	209	462	161	111	245	132	91	201	1	1	2
129	1170	810	1780	27.1	190	417	134	93	204	127	88	193	0	0	0
130	1210	880	1872	225	164	348	107	78	165	92	67	142	9	7	14
131	1343	1085	2157	216	174	345	114	92	182	80	65	129	26	21	41
132	816	790	1468	80	78	144	37	36	66	35	34	63	16	16	29
133	1113	1078	1897	154	150	264	69	67	117	74	72	126	0	0	0
134	752	728	1343	141	137	252	67	65	113	51	50	32	0	0	0
135	1166	920	1851	155	123	247	81	64	128	68	54	108	15	12	24
136	2076	1403	3070	365	246	533	174	118	258	149	100	220	1	1	2
137	1610	1158	2241	468	336	651	171	123	238	141	102	197	0	0	0
138	1548	1124	2133	414	300	570	182	132	251	162	118	224	31	22	43
139	1213	841	1747	125	87	181	64	44	93	34	23	49	30	21	43
140	1838	1174	2866	95	61	149	40	25	62	50	32	78	35	22	55
141	1541	932	2543	117	71	194	52	32	87	52	32	87	41	24	67
142	966	556	1682	33	19	58	20	11	35	6	3	11	6	3	11
14 3	786	43 8	1407	29	16	52	7	4	13	14	8	26	14	8	26
144	809	445	1492	45	25	84	7	4	14	38	21	70	15	8	28
145	1179	642	2188	0	0	0	0	0	0	0	0	0	39	21	72
146	603	326	1117	15	8	29	0	0	0	15	8	29	0	0	0
147	1471	786	2742	40	21	75	16	8	30	16	8	30	48	26	90
148	1040	556	1939	16	8	30	16	8	30	0	0	0	89	47	166
149	1077	588	1985	38	21	71	7	4	14	23	12	42	85	46	157
150	905	504	1610	29	16	51	0	0	0	7	4	12	0	0	0
151	1349	765	2382	62	35	111	20	11	37	27	[illegible]	49	0	0	0
152	357	200	632	35	20	63	14	8	25	14	8	25	0	0	0
** TOTAL **	39847	27458	64597	5697	4152	8837	2668	1954	4133	2423	1764	3781	514	316	890

STH = Steelhead Hach = Hatchery

Lat2 = Brand Group 1 Lat4 = Brand Group 2

LB = Lower Bound UB = Upper Bound

APPENDIX TABLE B. 18. DAILY ESTIMATED PASSAGE OF STEELHEAD AND COHO OUTMIGRANTS TO PROSSER WITH 90% CONFIDENCE LIMITS JUNE. 1984

DATE	# WILD STH	LB WILD STH	UB WILD STH	# HACH STH	LB HACH STH	UB HACH STH	# LAT2 HACH STH	LB LAT2 HACH STH	UB LAT2 HACH STH	# LAT4 HACH STH	LB LAT4 HACH STH	UB LAT4 HACH STH	# COHO	LB COHO	UB COHO
153	676	377	1210	29	16	52	23	16	52	0	0	0	44	24	70
154	678	378	1207	7	4	12	7	4	12	0	0	0	36	20	64
155	744	425	1301	68	39	120	13	7	24	34	19	60	6	3	12
156	597	349	1022	123	72	211	84	49	144	19	11	33	0	0	0
157	460	265	793	46	26	80	20	11	34	20	11	34	6	3	11
1511	178	100	316	14	8	25	7	4	12	0	0	0	0	0	0
159	94	52	168	0	0	0	0	0	0	0	0	0	0	0	0
160	44	24	80	0	0	0	0	0	0	0	0	0	0	0	0
161	71	38	132	0	0	0	0	0	0	0	0	0	0	0	0
162	52	27	101	0	0	0	0	0	0	0	0	0	0	0	0
163	29	14	60	0	0	0	0	0	0	0	0	0	0	0	0
164	71	34	148	0	0	0	0	0	0	0	0	0	0	0	0
165	58	28	117	0	0	0	0	0	0	0	0	0	0	0	0
166	101	51	200	0	0	0	0	0	0	0	0	0	0	0	0
167	160	82	310	0	0	0	0	0	0	0	0	0	17	9	34
168	71	36	140	8	4	17	0	0	0	a	4	17	0	0	0
169	57	28	115	0	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172	24	10	52	24	10	52	0	0	0	0	0	0	0	0	0
173	25	11	58	0	0	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	(	0	0
182	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
** TOTAL **	4190	2329	7530	319	179	569	160	91	278	81	45	144	109	59	199

STH = Steelhead Hach = Hatchery

Lat2 = Brand Group 1 Lat4 = Brand Group 2

LB = Lower Bound UB = Upper Bound

APPENDIX TABLEB.19. DAILY ESTIMATED PASSAGE OF STEELHEAD AND COHO OUTMIGRANTS TO PROSSER WITH 90% CONFIDENCE LIMITS JULY, 1984

DATE	# WILD STH	LB WILD STH	UB WILD STH	# HACH STH	LB HACH STH	UB HACH STH	# LAT2 HACH STH	LB LAT2 HACH STH	UB LAT2 HACH STH	# LAT4 HACH STH	LB LAT4 HACH STH	UB LAT4 HACH STH	# COHO	LB COHO	UB COHO
183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
184	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	147	68	317	0	0	0	0	0	0	0	0	0	0	0	0
187	JO	36	135	0	0	0	0	0	0	0	0	0	0	0	0
188	6	3	11	0	0	0	0	0	0	0	0	0	0	0	0
189	9	6	13	0	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
133	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
194	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0
195	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
197	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
198	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
203	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
** TOTAL **	240	121	484	0	0	0	0	0	0	0	0	0	0	0	0

STH = Steelhead

Hach = Hatcher

Lat2 = Brand Group 1

Lat4 = Brand Group 2

LB = Lower Bound

UB = Upper Bound

APPENDIX TABLE B.20. DAILY CAPTURES OF HATCHERY FINGERLINGS AT PROSSER 7/84

DATE	FINGERLINGS
840701	76
840702	63
840703	126
840704	1000
840705	457
840706	177
840707	747
840708	899
840709	253
840710	177
840711	126
840712	51
840713	152
840714	139
840715	63
840716	13
840717	89
840718	215
840719	342
840720	126
840721	253
840722	25
840723	152
840724	202
840725	129
840726	0
840727	0
840728	0
840729	38
840730	0
840731	0
** TOTAL **	6090

Table B.21.Passage of Adult Spring Chinook to Prosser, 1984
Prosser Dam, Mayl-July31, 1984
(1) Daily chinook total passage; (2) Daily proportion of chinook total passage; (3) Cumulative chinook total passage; (4) Cumulative proportion of chinook total passage.

DAY	DATE	(1)	(2)	(3)	(4)
2	502	6	0.0023	6	0.0023
3	503	10	0.0039	16	0.0063
4	504	20	0.0078	36	0.0141
5	505	15	0.0059	51	0.0199
6	506	28	0.0109	79	0.0309
7	507	7	0.0027	86	0.0336
8	508	21	0.0082	107	0.0418
9	509	16	0.0063	123	0.0481
10	510	37	0.0145	160	0.0625
11	511	51	0.0199	211	0.0825
12	512	23	0.0090	234	0.0915
13	513	119	0.0465	353	0.1380
14	514	136	0.0532	489	0.1912
15	515	159	0.0622	648	0.2533
16	516	140	0.0547	788	0.3081
17	517	136	0.0532	924	0.3612
18	518	147	0.0575	1071	0.4187
19	519	105	0.0410	1176	0.4597
20	520	85	0.0332	1261	0.4930
21	521	71	0.0278	1332	0.5207
22	522	78	0.0305	1410	0.5512
23	523	75	0.0293	1485	0.5805
24	524	84	0.0328	1569	0.6134
25	525	75	0.0293	1644	0.6427
26	526	20	0.0078	1664	0.6505
27	527	8	0.0031	1672	0.6536
28	528	59	0.0231	1731	0.6767
29	529	47	0.0184	1778	0.6951
30	530	91	0.0356	1869	0.7306
31	531	76	0.0297	1945	0.7604
32	601	48	0.0188	1993	0.7791
33	602	53	0.0207	2046	0.7998
34	603	23	0.0090	2069	0.8088
35	604	54	0.0211	2123	0.8299
36	605	38	0.0149	2161	0.8448
37	606	41	0.0160	2202	0.8608
38	607	34	0.0133	2236	0.8741
39	608	23	0.0090	2259	0.8831
40	609	8	0.0031	2267	0.8862
41	610	15	0.0059	2282	0.8921
42	611	16	0.0063	2298	0.8984
43	612	24	0.0094	2322	0.9077
44	613	24	0.0094	2346	0.9171
45	614	15	0.0059	2361	0.9230
46	615	21	0.0082	2382	0.9312
47	616	23	0.0090	2405	0.9402
48	617	19	0.0074	2424	0.9476

Table B.21. Prosser Dam, May 1 - July 31, 1984
(1) Daily chinook total passage; (2) Daily proportion of chinook total passage; (3) Cumulative chinook total passage; (4) Cumulative proportion of chinook total passage

DAY	DATE	(1)[a]	(2)	(3)	(4)
49	618	6	0.0023	2430	0.9500
50	619	8	0.0031	2438	0.9531
51	620	10	0.0039	2448	0.9570
52	621	18	0.0070	2466	0.9640
53	622	2	0.0008	2468	0.9648
54	623	6	0.0023	2474	0.9672
55	624	8	0.0031	2482	0.9703
56	625	10	0.0039	2492	0.9742
57	626	7	0.0027	2499	0.9769
58	627	4	0.0016	2503	0.9785
59	628	7	0.0027	2510	0.9812
60	629	1	0.0004	2511	0.9816
61	630	3	0.0012	2514	0.9828
62	701	4	0.0016	2518	0.9844
63	702	7	0.0027	2525	0.9871
64	703	1	0.0004	2526	0.9875
65	704	4	0.0016	2530	0.9891
66	705	2	0.0008	2532	0.9898
67	706	3	0.0012	2535	0.9910
68	707	1	0.0004	2536	0.9914
69	708	5	0.0020	2541	0.9934
70	709	4	0.0016	2545	0.9949
71	710	6	0.0023	2551	0.9973
72	711	2	0.0008	2553	0.9980
73	712	0	0.0000	2553	0.9980
74	713	2	0.0008	2555	0.9988
75	714	1	0.0004	2556	0.9992
76	715	0	0.0000	2556	0.9992
77	716	0	0.0000	2556	0.9992
78	717	0	0.0000	2556	0.9992
79	718	1	0.0004	2557	0.9996
80	719	0	0.0000	2557	0.9996
81	720	0	0.0000	2557	0.9996
82	721	1	0.0004	2558	1.0000

Mean Date: 24.4457 Variance: 161.759
Skewness: 1.18699 Kurtosis: 1.5308

Table B.22. Passage of Adult Spring Chinook toRoza Dam, 1984
Roza Dam, May 9 - September 6, 1984
(1) Daily chinook adult passage; (2) Daily proportion of chinook adult passage; (3) Cumulative chinook adult passage; (4) Cumulative proportion of chinook adult passage.

DAY	DATE	(1)	(2)	(3)	(4)
14	514	2	0.0015	2	0.0015
15	515	0	0.0000	2	0.0015
16	516	0	0.0000	2	0.0015
17	517	1	0.0007	3	0.0022
18	518	3	0.0022	6	0.0045
19	519	1	0.0007	7	0.0052
20	520	1	0.0007	8	0.0060
21	521	0	0.0000	8	0.0060
22	522	1	0.0007	9	0.0067
23	523	1	0.0007	10	0.0075
24	524	7	0.0052	17	0.0127
25	525	7	0.0052	24	0.0180
26	526	12	0.0090	36	0.0269
27	527	11	0.0082	47	0.0352
28	528	19	0.0142	66	0.0494
29	529	50	0.0374	116	0.0868
30	530	68	0.0509	184	0.1376
31	531	13	0.0097	197	0.1473
32	601	41	0.0307	238	0.1780
33	602	70	0.0524	308	0.2304
34	603	31	0.0232	339	0.2536
35	604	52	0.0389	391	0.2924
36	605	16	0.0120	407	0.3044
37	606	16	0.0120	423	0.3164
38	607	11	0.0082	434	0.3246
39	608	24	0.0180	458	0.3426
40	609	18	0.0135	476	0.3560
41	610	10	0.0075	486	0.3635
42	611	71	0.0531	557	0.4166
43	612	95	0.0711	652	0.4877
44	613	85	0.0636	737	0.5512
45	614	13	0.0097	750	0.5610
46	615	54	0.0404	804	0.6013
47	616	19	0.0142	823	0.6156
48	617	7	0.0052	830	0.6208
49	618	10	0.0075	840	0.6283
50	619	31	0.0232	871	0.6515
51	620	18	0.0135	889	0.6649
52	621	16	0.0120	905	0.6769
53	622	2	0.0015	907	0.6784
54	623	9	0.0067	916	0.6851
55	624	19	0.0142	935	0.6993
56	625	8	0.0060	943	0.7053
57	626	15	0.0112	958	0.7165
58	627	7	0.0052	965	0.7218
59	628	3	0.0022	968	0.7240
60	629	49	0.0366	1017	0.7607

Table B.22. Roza Dam, May 9 - September 6, 1984
(1) Daily chinook adult passage; (2) Daily proportion of chinook adult passage; (3) Cumulative chinook adult passage; (4) Cumulative proportion of chinook adult passage.

DAY	DATE	(1)	(2)	(3)	(4)
61	630	5	0.0037	1022	0.7644
62	701	9	0.0067	1031	0.7711
63	702	38	0.0284	1069	0.7996
64	703	111	0.0830	1180	0.8826
65	704	20	0.0150	1200	0.8975
66	705	26	0.0194	1226	0.9170
67	706	32	0.0239	1258	0.9409
68	707	4	0.0030	1262	0.9439
69	708	3	0.0022	1265	0.9461
70	709	0	0.0000	1265	0.9461
71	710	4	0.0030	1269	0.9491
72	711	7	0.0052	1276	0.9544
73	712	1	0.0007	1277	0.9551
74	713	2	0.0015	1279	0.9566
75	714	2	0.0015	1281	0.9581
76	715	1	0.0007	1282	0.9589
77	716	2	0.0015	1284	0.9604
78	717	1	0.0007	1285	0.9611
79	718	2	0.0015	1287	0.9626
80	719	0	0.0000	1287	0.9626
81	720	0	0.0000	1287	0.9626
82	721	0	0.0000	1287	0.9626
83	722	0	0.0000	1287	0.9626
84	723	1	0.0007	1288	0.9634
85	724	1	0.0007	1289	0.9641
86	725	2	0.0015	1291	0.9656
87	726	2	0.0015	1293	0.9671
88	727	1	0.0007	1294	0.9678
89	728	0	0.0000	1294	0.9678
90	729	0	0.0000	1294	0.9678
91	730	1	0.0007	1295	0.9686
92	731	5	0.0037	1300	0.9723
93	801	1	0.0007	1301	0.9731
94	802	0	0.0000	1301	0.9731
95	803	1	0.0007	1302	0.9738
96	804	1	0.0007	1303	0.9746
97	805	0	0.0000	1303	0.9746
98	806	0	0.0000	1303	0.9746
99	807	1	0.0007	1304	0.9753
100	808	2	0.0015	1306	0.9768
101	809	3	0.0022	1309	0.9791
102	810	1	0.0007	1310	0.9798
103	811	2	0.0015	1312	0.9813
104	812	2	0.0015	1314	0.9828
105	813	1	0.0007	1315	0.9835
106	814	0	0.0000	1315	0.9835
107	815	0	0.0000	1315	0.9835

Table B. 22 Roza Dam, May 9 - September 6, 1984
(1) Daily chinook adult passage; (2) Daily proportion of chinook adult passage; (3) Cumulative chinook adult passage; (4) Cumulative proportion of chinook adult passage.

DAY	DATE	(1)	(2)	(3)	(4)
108	816	0	0.0000	1315	0.9835
109	817	0	0.0000	1315	0.9835
110	818	1	0.0007	1316	0.9843
111	819	0	0.0000	1316	0.9843
112	820	0	0.0000	1316	0.9843
113	821	0	0.0000	1316	0.9843
114	822	1	0.0007	1317	0.9850
115	823	0	0.0000	1317	0.9850
116	824	0	0.0000	1317	0.9850
117	825	0	0.0000	1317	0.9850
118	826	2	0.0015	1319	0.9865
119	827	8	0.0060	1327	0.9925
120	828	1	0.0007	1328	0.9933
121	829	0	0.0000	1328	0.9933
122	830	0	0.0000	1328	0.9933
123	831	1	0.0007	1329	0.9940
124	901	0	0.0000	1329	0.9940
125	902	0	0.0000	1329	0.9940
126	903	3	0.0022	1332	0.9963
127	904	0	0.0000	1332	0.9963
128	905	2	0.0015	1334	1.0000

Mean Date: 47.8916 Variance: 309.476
Skewness: 1.57896 Kurtosis: 4.08392